The Journal of ELECTRICITY POWER and GAS

DEVOTED TO THE CONVERSION, TRANSMISSION and DISTRIBUTION OF ENERGY.

VOL. XIII.—No. 3 SAN FRANCISCO, CAL., MARCH, 1903. YEARLY SUBSCRIPTION - $2.00 SINGLE COPIES - 25 CENTS

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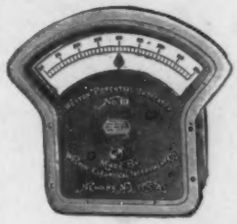

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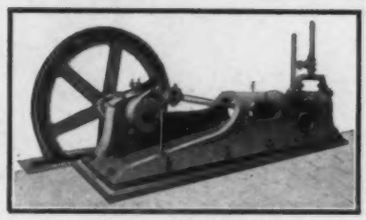

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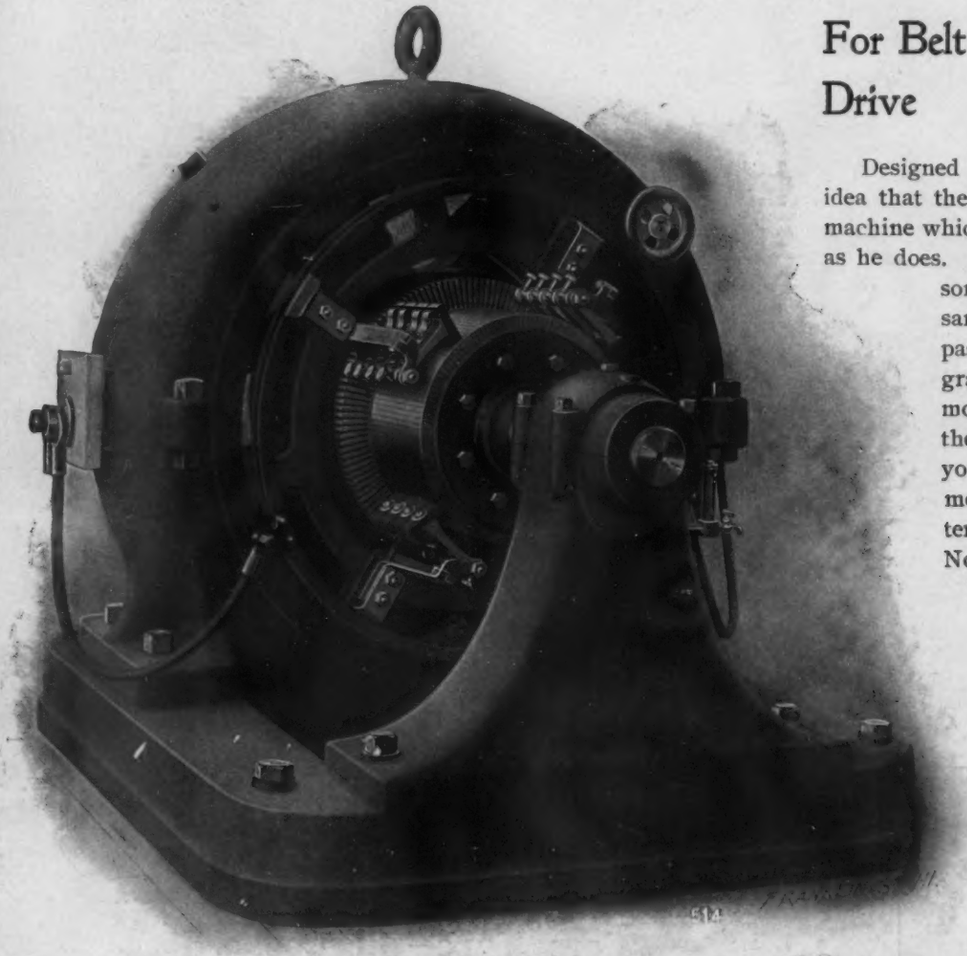

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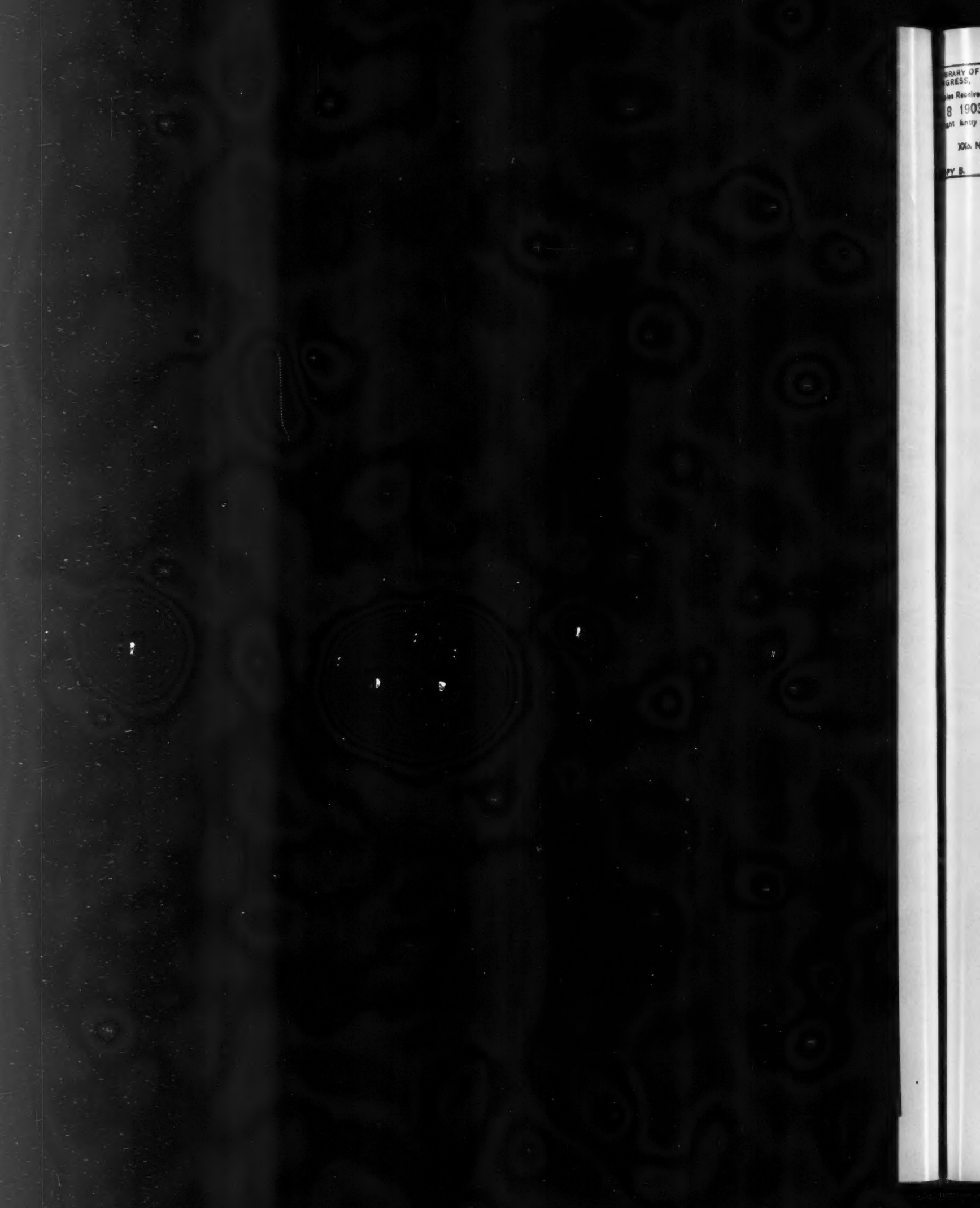

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The Journal of Electricity, Power and Gas.

Devoted to the Conversion, Transmission and Distribution of Energy.

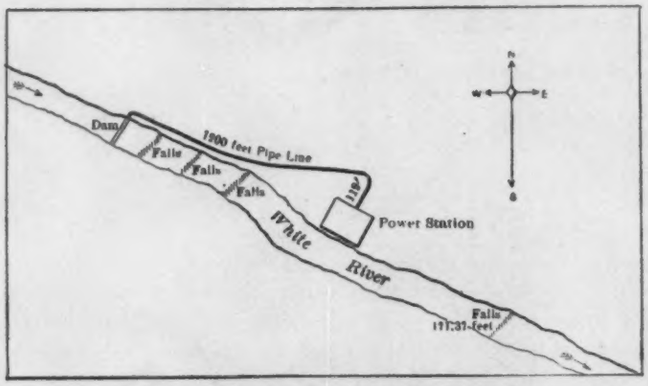
VOLUME XIII. SAN FRANCISCO, CAL., MARCH, 1903. NUMBER 3

The White River-The Dalles Transmission.

THE beginning of the corporation which recently completed The Dalles 20,000-volt transmission plant goes back to September 11, 1883, when the Wasco Warehouse Company was formed for the purpose of engaging in the wool business and in forwarding and storing general merchandise. In 1890 another corporation, known as The Dalles Electric Light and Power Company, was formed for the purpose of furnishing light and power. In 1901 the above corporations were consolidated into the Wasco Warehouse Milling Company, having a capital stock of $300,000, and composed of leading business men and bankers. It having been determined to build a flouring mill at The Dalles of a capacity of 700 barrels a day, the question arose as to what to use for power. It was quickly decided that electric power was the most feasible, as within a few miles there are many undeveloped waterfalls, among which may be mentioned one at Hood River, twenty-two miles west; another at Klickatat River in Washington, twenty miles west; the Celilo Falls in the Columbia River, with a fall of thirty-four feet, about twelve miles east; the Des Chutes River, eighteen miles east, and the White River, a branch of Des Chutes River, twenty-seven miles south. After careful examination of all, the latter was found to possess the most advantages, including the lowest cost for development, and in 1901 a contract was let to the Pacific Bridge Company, of Portland, to develop the power and build the transmission plant. Work was started in August, 1901, and the plant was to be completed before November 15, 1901, but through unforeseen delays it was not ready for operation until January 5, 1902.

The plant is situated as a bird flies, twenty-seven miles south of The Dalles at White River Falls in Wasco County, Oregon. There are two falls in the river at the head of the works, and the power station, which is of stone, thirty feet by sixty feet, is at the bottom of the second fall. The plant is placed ten feet above the level of the river, and utilizes a head of 131 feet, the ten feet insuring that there will be no interference from freshets in the river. At the head of the falls there is a concrete

THE FALLS OF THE WHITE RIVER, WASCO COUNTY, OREGON.



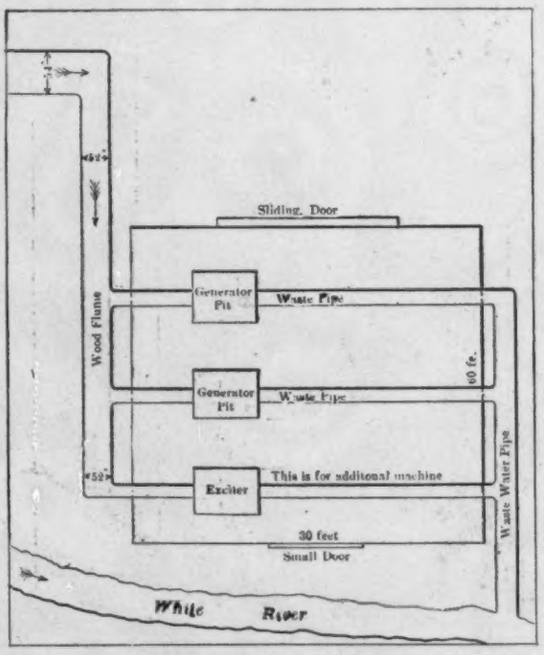
MAP SHOWING LOCATION OF THE WHITE RIVER PLANT

dam eight feet high, from which the water is carried in a wooden flume fifty-four inches in diameter and 1200 feet long laid with one foot fall to a hundred, and delivering a head of 119 feet at the water wheel pit. There are at present three water wheels, two of which are direct connected to two three-phase, 500-kilowatt, 2300-volt, generators, operating at sixty cycles, and of a current capacity of 126 amperes each. The other wheel is direct connected to a thirty-kilowatt exciter. This wheel is also in reserve for another generating machine in case growth requires its output. The water wheels were made by Knight & Co., of Sutter Creek, Amador County, Cal., and the electrical apparatus by the General Electric Company. The current passes through three 400-kilowatt step-up transformers of the air-blast type, in which its voltage is raised to 22,000. The transformers are connected in delta, and are cooled by air furnished by a blower, a second blower being held in reserve. There are three oil switches.

In the Knight water wheels with which the plant is equipped, there is found a type of hydraulic prime mover which, though used to a very considerable extent throughout the West, is generally not well known because of the fact that no detailed description of its basic and operative principles has ever been published. This seems extraordinary when it is remembered that the hydraulic work of its inventor, Mr. Samuel N. Knight, of Sutter Creek, Amador County, Cal., was done along the Mother Lode from an early date that was co-incident with that of Pelton, Coleman, Moore, Hesse and others whose names are prominently connected with the history of the development of the form of water wheel so generally known as the "Pelton type" wheel.

The undoubted forerunner of this type of wheel was the now-historic "hurdy-gurdy" wheel of the early California gold miners and which, in a description accredited to Mr. Knight,* was made of blocks of wood about four inches thick, cut out like the teeth of a circular saw, with teeth about eight inches apart. These teeth or buckets were then closed in by casings of wood which formed the sides of the wheel, and from these sides four arms, or spokes, were mortised into a log, the end of which was fitted with a round gudgeon for a bearing. The gudgeon was then placed in a live oak block which had previously been gouged out for the bearing, and this gouging out was generally very roughly done, because of the poor quality of tools which the miner of those days had at his disposal. The water was applied at first in the form of a jet emanating from a hole bored into the end of a wooden block with which the pipe had been plugged. Sometimes the pipe line was of sheet iron and sometimes it was of wood. With heads varying from forty to fifty feet, square wooden pipes were frequently used, these being merely square wooden boxes bolted together with iron rods, if they could be secured, or otherwise the box would be clamped together by means of wood frames, cleats and wedges.

Hurdy gurdy wheels and wood pipe lines of the forms just described were considered good practice in 1854, but as time passed and small quartz mills were erected, it was found that the sphere of usefulness of the hurdy gurdy could be increased to the driving of stamp mills, which it did fairly well when brass nozzles and moderately high heads were used as became the common practice. The question of efficiency was never taken into consideration until hurdy gurdy wheels were applied to the operation of large stamp mills, and then it was found that the hurdy gurdy would not develop the power required to give the mill the proper speed, the cause being attributed to the fact that as the buckets were closed in at each side and on the bottom, the waste water could not discharge itself freely, in consequence of which the buckets would remain full during the greater portion of the time during which they remained in the jet. All additional water directed against the bucket after it was filled, merely slipped over the face of the water already in the bucket, and out into the open air. The hurdy gurdy was a pure impact wheel, and at that time but little if any thought had been given to the reaction of



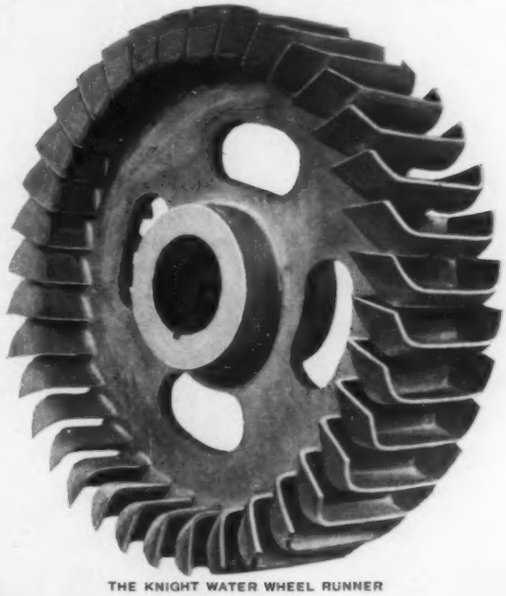
GENERAL PLAN OF THE WHITE RIVER POWER HOUSE

*See THE JOURNAL, Volume VIII, page 85; October, 1899.

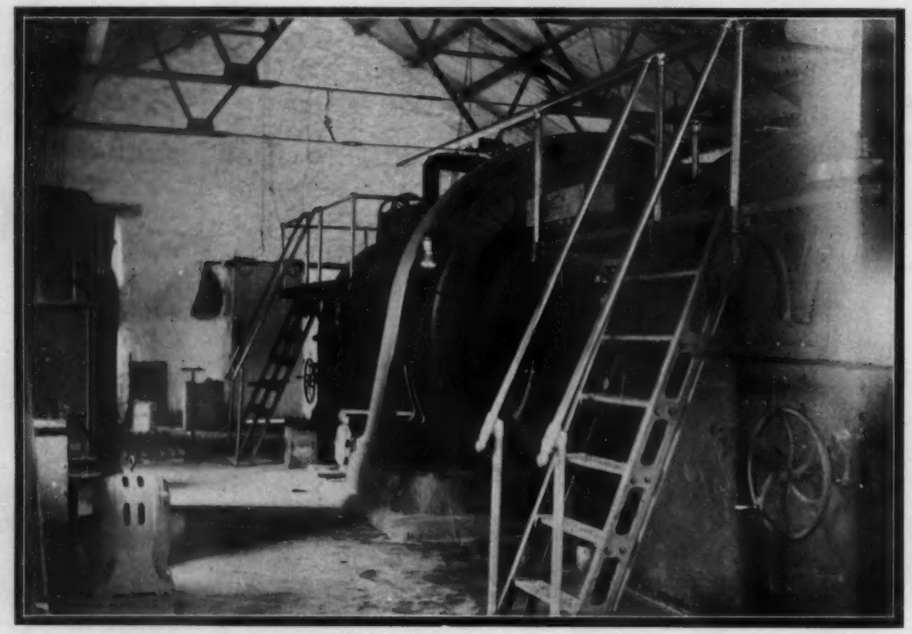
A KNIGHT WATER WHEEL UNIT

water as applied to the present forms of tangential wheels. In 1870 Mr. Knight brought out a new type of bucket which was a marked improvement over all previous forms, as was demonstrated by its installation in the Gwin Mine in 1872, where it operated a twenty-stamp mill. This wheel was of the true tangential type and its buckets were so shaped that they had both side and inward discharges, while most of the latter types of bucket have mainly side discharges. The stream of water applied to the Knight bucket is of rectilinear cross section. But, to revert to the historical side of the matter, the first Knight wheel was made in 1870 and it presented no radical departure from the present form of Knight wheel. In 1872 a Knight wheel was placed in the Gwin Mine to operate a twenty-stamp mill, this wheel being first equipped with buckets having an inward discharge; next they were changed to those having side discharges, and finally the present form was adopted, which has both inward and side discharges.

Strictly speaking, the Knight water wheel favors hydraulic turbines in design more than it does tangential wheels, although if superficially considered it will perhaps be regarded as belonging to the so-called Pelton type. It more properly forms a class by itself, which class Mr. Knight prefers to call the "pressure-reaction" water wheel, for in addition to availing itself of the power to be derived from the direct pressure of water, as in the ordinary turbine, the Knight wheel further avails itself of the reactionary forces of water under pressure, which play such an important part in the tangential or Pelton type wheel. Hence the derivation of the term, "pressure-reaction." To understand the principles of the Knight wheel will be an easy matter to those who are familiar with both turbine and tangential water wheel practices. Reference to the accompanying drawings and half-tone will enable a description of this very interesting type of wheel to be given. The wheel proper is outwardly of the tangential appearance, in that it consists of thirty-six buckets mounted upon the periphery of a center disc, exactly as is done in standard Pelton practice. The buckets, however, are not divided by a center wedge, but, instead, are cup-shaped in a combination between a rectilinear and an oblong form. The entering lip possesses no unusual features, but the discharge lips are so formed that the discharge takes place equally at the sides and rear of the buckets, that is at the ends and from the side nearest the center of the wheel. In this the discharge is not entirely unlike that of Pelton type buckets, for the wheel is impelled forward by reaction from the center (or back) and the sides of the buckets. But beyond this, and which is probably of more importance in the development of power in this particular case, the water is not applied to the buckets in the form of a jet; instead it is applied through openings of rectilinear cross section which are placed practically in contact with the outer lips of the buckets, so that the outer knife-edge of the bucket splits off a definite portion of water which imparts most of its energy to the wheel by reason of direct pressure, almost precisely as is done in turbine work. The number of these water supply openings, which may conveniently be termed nozzles, although the word is a misnomer, may be varied to suit the amount of water available or the power desired, hence Knight wheels are equipped with any number of such nozzles from one to the number required to carry an uninterrupted line of nozzles clear around the periphery of the wheel, and in all cases the discharge is perfect, for obviously the absence of jets makes interferance therewith impossible. In the hydraulic plant installed for The Dalles transmission, the wheels are provided with seven nozzles of the form described, and the position of these so-called nozzles with reference to the wheel is clearly shown in the drawing given on page 160, where they encompass, over all, practically 165 degrees of the circumference of the wheel. Only the center one of these seven nozzles is shown to be in the open position, for by means of suitable hand wheels on the outside of the wheel casing, vanes shaped in arcs of circles may be moved by racks and pinions so as to close or open the nozzles at will. The wheel discs in this instance are of cast iron, having a thickness of one and one-fourth inches and a diameter of forty-five and



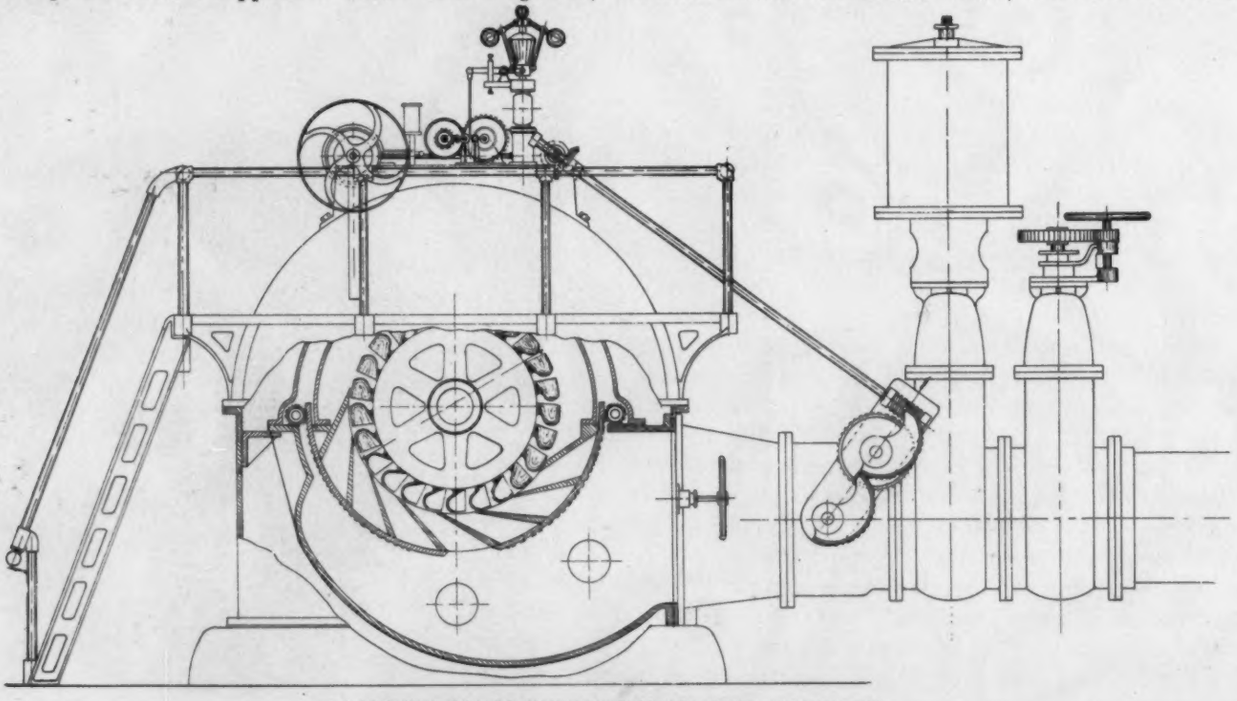
THE KNIGHT WATER WHEEL RUNNER



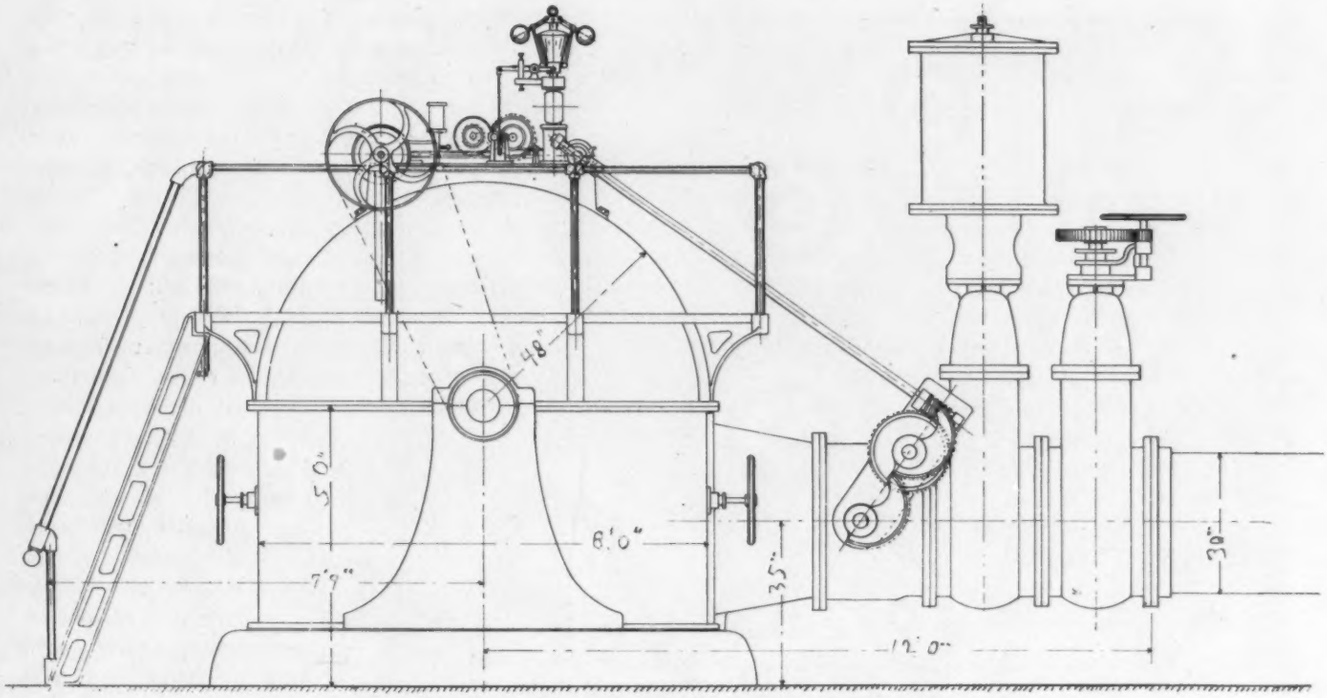
THE DALLES TRANSMISSION. WATER WHEEL AND GENERATOR SIDE OF THE POWER HOUSE

three-eighths inches. The Knight buckets are of iron, cast on the disc, although bronze is the material used in instances where the wheels are to operate under high heads, the ring carrying the buckets being shrunk onto the steel center. The clearance between the tips of the nozzles and the lips of the buckets is only sufficient to give mechanical freedom in the rotation of the wheel, and the action of the buckets is such that they split off from each nozzle a given section of water from which they absorb its energy, which is imparted in the form of both direct pressure and reaction of the discharge, as stated. In The Dalles plant, water is supplied at a static head of 130 feet, and the wheels with all seven nozzles open deliver 900 horsepower at a speed of 225 revolutions per minute, the peripheral speed of the wheel being 46 per cent. of the theoretical velocity of the water at the nozzle. In this ratio is found a close parallel to that which exists in ordinary tangential wheel practice, for it expresses the speed at which highest efficiency will be attained in the use of Knight wheels, and as to the efficiency, it may be stated that in The Dalles plant an efficiency of 82 per cent. was made with a single nozzle. This gave approximately one-seventh of the total power of the wheel, or to be exact, 134 horsepower was delivered and absorbed by a Prony brake, indicating a total power output of 938 horsepower for the seven nozzles. It is to be regretted that at the time of making the test it was not practicable to handle a heavier load than that given, but it is confidently believed that the efficiency of the Knight wheel will always reach between 80 per cent. and 85 per cent., in view of which its makers, Messrs. Knight & Co., of Sutter Creek, Cal., stand ready to guarantee an efficiency of 80 per cent. on all wheels which they build.

Reverting to the details of hydraulic equipment installed for The Dalles plant, it may be stated that the knife-edges or lips of the buckets are separated a distance of four and three-sixteenths inches, and that each nozzle



A SECTIONAL DRAWING OF THE KNIGHT WATER WHEEL AND GOVERNOR



ELEVATION OF THE HOUSING AND GOVERNOR OF THE KNIGHT WATER WHEEL

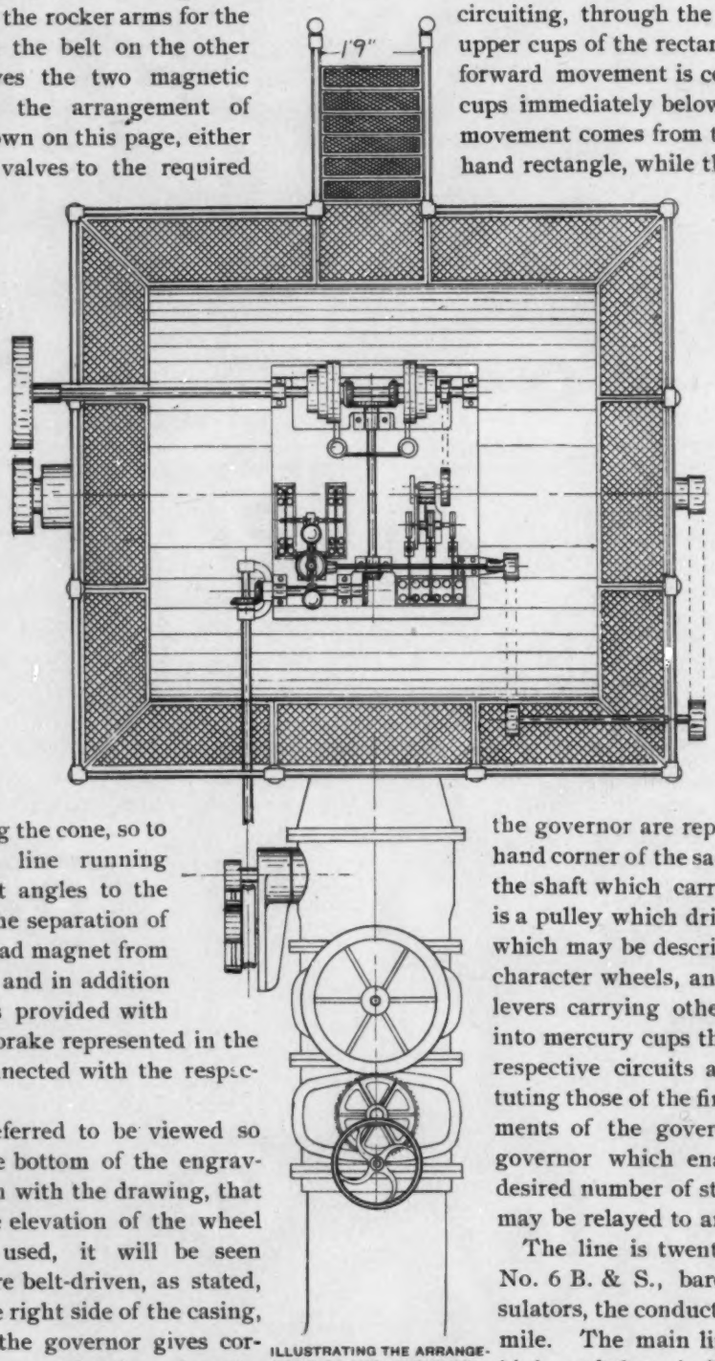
has a width of four inches at the tip and of five inches at the base. Water is supplied through a wood stave pipe terminating in two gate valves, which were also furnished by Messrs. Knight & Co. The first of these gate valves is designed to be operated manually by a hand wheel, so that its use can be resorted to in event of the failure of the second gate valve, which is actuated by a water piston controlled by a three-way valve placed on the main switchboard of the station. These gate valves appear in both the sectional and elevation drawings of the water wheel equipment, which also show the hand-wheels controlling the number of nozzles used, the arrangement of the butterfly valve in the main pipe line immediately preceding the goose-neck carrying the nozzles, as well as the location of the governor on top of the wheel housing and the method of applying power from the main wheel shaft for its operation. Each wheel shaft carries two 4000-pound flywheels.

One point further regarding the Knight wheel remains to be discussed, and that is relative to the heads of water under which it may be designed to run. It may be stated with conservatism that the Knight wheel may be applied with satisfaction to any moderate head, that is, any head up to say 800 or 900 feet, beyond which it is not believed that it will attain results as efficient as those possible from the use of wheels of the strictly Pelton or tangential class. The highest head under which a Knight wheel is operating is 720 feet, at the Plumas Eureka Mine, in Plumas County, Cal., while elsewhere Knight wheels have been and are still in operation under as low as a four-foot head. Among the recent noteworthy installations of wheels of this class is one that has just been put in service for the Standard Electric Company at its New York Ranch reservoir, in Amador County, where a Knight wheel operates under a head of seventeen feet and its power is used to raise sixty miners inches of water a height of 103 feet into the reservoir for hydraulicking.

The distinguishing feature of the Knight governor, aside from its being essentially an electrical device, rests in the fact that it is provided with variable steps to control such increase or decrease as may occur in the speed of the ungoverned water wheel. For instance, if a gradual change of load takes place sufficient to tend to raise the speed by 1 per cent., that which may be referred to as the first movement of the governor takes place and the wheel gate is moved towards closing by one-sixth of a given period of time,—say one second of time in six seconds; that is, the gate is moved for one second and stands at rests during the remaining six seconds of the period. If, now, the speed should continue to raise to 1½ per cent., the second movement takes place and moves the gate say one-third of the given period of time, and if this should not prove to be sufficient to bring the speed of the wheel back to within the scope of the first movement, the third and final movement of the governor occurs This third movement is continuous, and as a result the governor continues to close the gate uninterruptedly until the speed of the wheel has been reduced to within 1½ per cent. of normal, when automatically the second movement steps into action, handling the speed until it has been brought down to 1 per cent., when again an automatic action throws the control into the first movement, which is very slow, and thus the speed is brought to normal. In case of heavy overload or other unusual condition, the governor will hold the speed within 5 per cent. on either side of normal. In the governor installed in the power house of The Dalles transmission, four variable steps of the nature above described

were provided, these being gaged to two, three and five seconds per period for the first three movements, and continuous operation for the fourth movement.

The arrangement of the governor on top of the wheel housing is particularly convenient and pleasing. The mechanism of the governor is actuated direct from the main water wheel shaft through belting, that at one end of the housing being designed to drive the governor balls, the relay mechanisms and the rocker arms for the electrical contracts, while the belt on the other side of the housing drives the two magnetic clutches which, through the arrangement of shafts and bevel gears, shown on this page, either open or close the butterfly valves to the required degree. These magnetic clutches are an improvement over the five that are in use at the Pioneer Electric Power Plant at Ogden, Utah, made in 1897, are fashioned after those in use on the main line of shafting of the Sacramento substation of the Sacramento Electric, Gas and Railway Company, in which the clutch is split in two parts one of which contains an annular coil so placed as to form an iron clad electro-magnet, while the other part is solid and constitutes its armature. In the drawing, the largest pulley of the three forming the cone, so to speak, is divided by a line running through its center at right angles to the shaft. This line marks the separation of the armature of the iron clad magnet from the electro-magnet itself, and in addition each of these armatures is provided with a magnetically actuated brake represented in the form of double circles connected with the respective armatures.



ILLUSTRATING THE ARRANGEMENT OF THE KNIGHT GOVERNOR AND GATE VALVES

If the diagram last referred to be viewed so that the pipe line is at the bottom of the engraving, and if in conjunction with the drawing, that on page 161, showing the elevation of the wheel casing and governor be used, it will be seen that the governor balls are belt-driven, as stated, from the main shaft at the right side of the casing, and that the position of the governor gives corresponding motion to a lever which drops into the mechanism of the governor. Taking, first, the mechanism immediately under the upper of the two governor balls, there appears two rectangles, in each end of each of which are four small circles. These circles represent mercury cups, into which dip Ω-shaped wires that are attached to rocker arms placed over the respective rectangles. The rocker arms are actuated by the governor lever, before referred to, in such a way that the upper four cups of the respective rectangles give forward motion to the wheel gate, while the four lower cups of each rectangle give backward motion. That is, the first forward movement above described is given by the short-circuiting, through the Ω-shaped wire, of the two upper cups of the rectangle to the left; the second forward movement is controlled through the two cups immediately below them; the third forward movement comes from the upper cups of the right hand rectangle, while the fourth and final or continuous forward movement of the governor is caused by the short circuiting of the two lower cups of the upper set of the right hand rectangle. The four backward movements occupy respective positions on the lower halves of the rectangles. It is obvious that the circuits so controlled act on either one or the other of the iron clad magnets by successive steps, as stated, and that the release of all these cup-contacts causes the throwing on of the electro-magnetic brake. The relaying features of the governor are represented in the lower right hand corner of the same drawing. Belted from the shaft which carries the magnetic clutches is a pulley which drives a set of three wheels which may be described as adjustable cams, or character wheels, and which, in turn, operate levers carrying other Ω-shaped wires dipping into mercury cups that are in series with the respective circuits above described as constituting those of the first, second and third movements of the governor. The result is a governor which enables regulation by any desired number of stages of action, and which may be relayed to any desired degree.

The line is twenty-seven miles long, and of No. 6 B. & S., bare copper wire on glass insulators, the conductors being transposed every mile. The main line poles are thirty-five feet high, and those in The Dalles sixty feet high, all being of cedar with eight-inch tops. There is a telephone line six feet below the high-potential line, transposed every five poles. No inductive effect whatever has been noticed in telephone transmission.

The substation at The Dalles is built of brick, the dimensions being twenty-seven by forty-five feet. It contains three transformers, each of 375 kilowatts, air-cooled by a blower under a pressure of five-eighths ounce, a second blower being held in reserve. The voltage is here reduced to 1100 for distribution. There is also one thirty-five-light constant current six and six-tenths ampere transformer. The high-potential switches are of the oil-break type, mounted in a brick vault. There are also two oil-break switches on the low-potential circuit. The thirty-five-light transformer is for street lighting, the arc lamps used being of the enclosed type and of 1200 candle power, all connected in series. Each lamp takes about seventy-two volts at the arc. The flouring mill has two induction motors, one of 200 horsepower and one of fifty horsepower, operating at 1040 volts. The larger motor runs the mill, and the smaller one operates the elevator. The city lighting circuit has a potential of 1040 volts, which is stepped down to 104 volts for incandescent lighting.

THE TRANSFORMER AND SWITCHBOARD SIDE OF THE POWER HOUSE.

SAN FRANCISCO'S COMMERCIAL IMPORTANCE.*

BY GEO. A. NEWHALL.

IN the annual report of the president of the Chamber of Commerce of San Francisco last year, it was stated that up to that time San Francisco had never attained anything like the bank clearances and other financial transactions which had been recorded during 1901 since the founding of the city, but the year 1902 seems to have surpassed all, for its bank clearances amounted to $1,373,362,025.31, or an increase of $195,192,489.01 over the preceding year which was adjudged to be so successful. This increase was an average of $16,257,707 per month, or more than $500,000 per day for every day in the year. The clearance for the month of December, 1902, was the largest for any one month in the history of this our great city of the Pacific,—the total being $136,571,697.04 Comparing the record of 1902 with the clearances of other cities of the country, say for the first six months of 1902, and taking into consideration the trade conditions, I say that San Francisco has nothing to be ashamed of, as it figures seventh on the list. New York, of course, comes first with over thirty-seven billions dollars; Chicago is second with four and one-half billions; Boston is third with about three and one-half billions; Philadelphia is fourth with nearly three billions; then fifth comes St. Louis with over one billion, and next sixth comes Pittsburg with an even billion of dollars and then comes San Francisco with over six hundred and thirty millions during the first half of the year. These are the seven leading cities of the United States in volume of bank clearances. Chicago, Philadelphia and St. Louis show a decrease for the first half year as compared with the first six months of 1901; on the other hand, San Francisco's proportionate gain is greater than any of the cities enumerated.

Again, taking all the leading cities of the west, San Francisco, Denver, Salt Lake City, Los Angeles, Seattle, Portland, Tacoma, Spokane and Helena, San Francisco leads in the increase in bank clearances of these cities; San Francisco's total clearances for the first six months of 1902 being $82,995,319, which is greater than the combined figures of all the other cities named. The aggregate increase of all these nine cities for the six months is $179,729,360 and San Francisco's increase is nearly one-half of this total amount.

San Francisco's merchandise exports by sea have also increased; the aggregate during the year being $45,000,000. The imports by sea were $36,780,000. Our exports to Europe alone were over $14,000,000; to Mexico over $1,500,000; to Central America over $2,000,000; to the Pacific Islands $740,000; to the Philippine Islands over $1,000,000; Japan $4,000,000; China nearly $6,000,000 —being next to our exports to Europe—showing the importance of our trade with China. To Australia we exported nearly $4,000,000 worth of articles. To British Columbia over $1,000,000 worth; to South Africa $700,000. Our business with South Africa if carefully cultivated will increase materially. Siberia also figures in our exports to the extent of over $200,000. The exports to the Atlantic States by sea were nearly five millions.

*Extract from the presidential report to the Annual Meeting of the Chamber of Commerce of San Francisco, Cal., January, 1902.

AN ELECTRICAL ANTIQUITY IN OREGON.

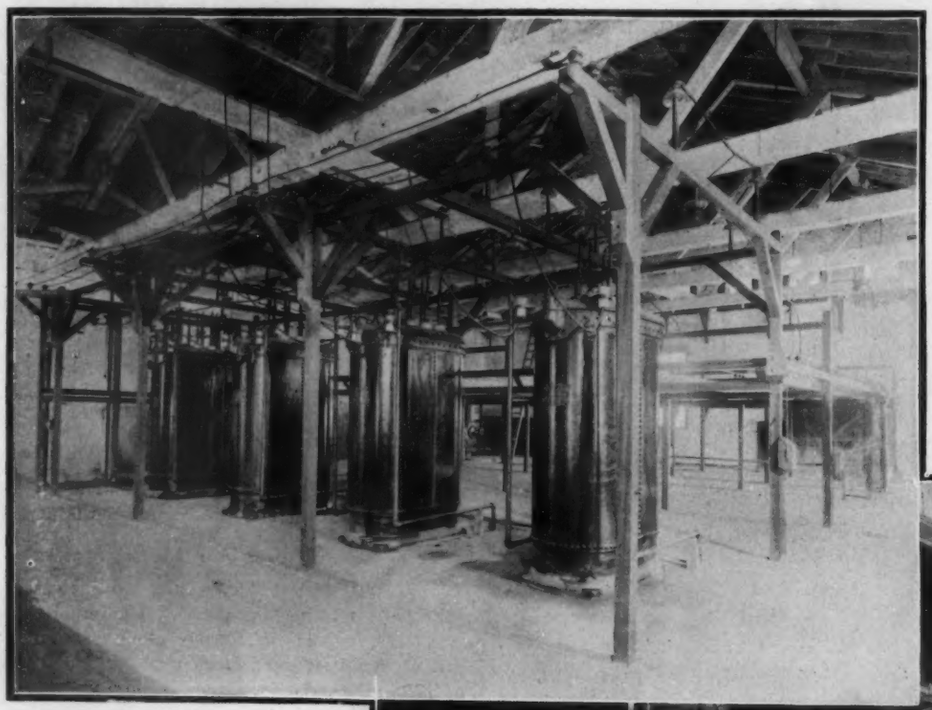
PASSENGERS traveling over the Northern Pacific between Portland and Tacoma who are interested in electrical antiquities, should visit the engine room of the ferryboat Kalama, as the train crosses the Columbia River, where will be found an original "Z Type" Edison bipolar dynamo which has been in continuous use since September, 1884, when the boat was built and placed in service. More than this, for three years or so prior to that time the dynamo referred to was one of two similar machines which were used in company with a ten-light Weston arc dynamo in lighting Ainsworth Dock, Portland. The latter plant was in charge of William H. Meeker, an exceedingly promising young man. who died shortly after the date first named.

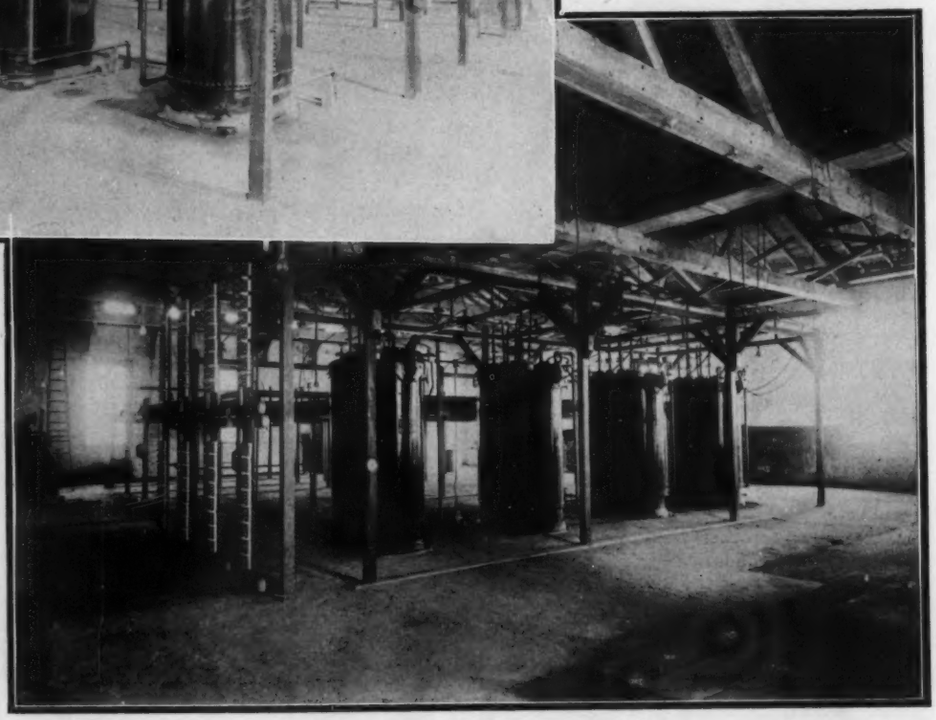
Announcement of the building of a 500,000-volt transformer for experimental purposes by Professor Harris J. Ryan, of Cornell University, who is collaborating with Professor Harold B. Smith, of the Worcester (Mass.) Polytecnic Institute, in the field of extremely high tension transformation and transmission, is contained in a recent issue of an engineering contemporary.* The transformer has been perfected in theory by Professor Ryan and by Professor Smith in practice, but no details concerning its structure or behavior are at hand.

**The Sibley Journal of Mechanical Engineering*, Volume XVII, page 200, February, 1903.

HIGH TENSION SWITCHING ON AN HEROIC SCALE.

COLUMN after column has appeared in these pages descriptive of designs and discussive of performances of high tension switching devices, but by far the most extraordinary arrangement yet adopted for handling high electric line pressures is that installed by the Butte Lighting and Power Company, of Butte, Mont., in the receiving substation in the city named, wherein





THE MADISON RIVER HIGH TENSION SWITCHING AND TRANSFORMER STATION OF THE BUTTE ELECTRIC AND POWER COMPANY, BUTTE, MONTANA

is received power from the transmission line of the Madison River Power Company, and wherein a brick building practically fifty feet by 100 feet in size, is exclusively devoted to the purpose of high tension switching, fusing and transforming. No other apparatus is within the building, although adjoining it are the machine shops of the Butte Lighting and Power Company.

But it is well to review the general conditions under which this high tension switching and transformer building is operated, for they are of much interest. Some thirty miles in a northwesterly direction from Bozeman, Mont., or, to be exact, at the town of Gallatin, a station on the Northern Pacific Railroad, the Jefferson, Madison and Gallatin rivers join their waters at a common point, and thenceforth the stream constitutes the mighty Missouri River. The center one of these three streams, or the "Three Forks" as they are locally termed, is the Madison River, upon which, at a point something less than sixty miles from the city of Butte, the Madison River Power Company has built a power house for the transmission of power into Butte. The system is designed for an 80,000-volt line, but thus far the load has not been sufficient to warrant experimenting at that extreme pressure, hence it has been operated ever since the inauguration of its service, in the spring of 1902, at 40,000 volts. Nevertheless, the receiving end of the system in Butte is laid out for the handling of 80,000 volts, and for a few hours the transmission has been operated at that potential, and so satisfactory was its performance that it is locally believed that when the climate of Montana is considered, 80,000-volt transmission is to be relied upon even in the present condition of insulator development during almost every month in the year. The line is supported on No. 1 "Provo" type glass insulators, having a diameter of seven inches across the bell, and were it to be run regularly at 80,000 volts, it is probable that No. 0 "Provo" type glass insulators would be used.

The transformers contained in the Butte substation referred to are of no little interest. It was in December, 1901, that the General Electric Company was asked by the Butte Lighting and Power Company to submit a bid

on a transformer which would enable the local company to utilize some 1200 horsepower from the Madison River transmission at a delivered potential of 80,000 volts. The manufacturing company did not consider it the best of engineering to use so high a voltage on a transmission of but sixty miles, but, nevertheless, it was willing to undertake the work, and as a result it was awarded a contract for the building of four 330-kilowatt transformers, to receive either 80,000 or 40,000 volts in star connection on the high side, and to deliver 2200 volts in three-phase current into the local lighting and power circuits of the Butte Lighting and Power Company.

In general design these transformers closely follow the standard oil-immersed, water-cooled transformer built by the General Electric Company, and except for allowance for the increased voltage, they are identical with the 500-kilowatt transformers built by the same manufacturers for the Piedmont substation, Oakland, of the Bay Counties Power Company, which have now been in continuous operation for nearly two years at practically 45,000 volts. The coils of which the windings of the transformers at Butte are composed are wound with flat copper strip and are remarkable strong and rigid considering the small conductors that must be used in the building of such a voltage in such a comparatively small unit. These coils are covered in the factory with only sufficient waterproof insulation to exclude any moisture which might be deposited upon them during transportation, and as a result, the heat generated in them can escape as easily as from the coils of a much lower voltage transformer.

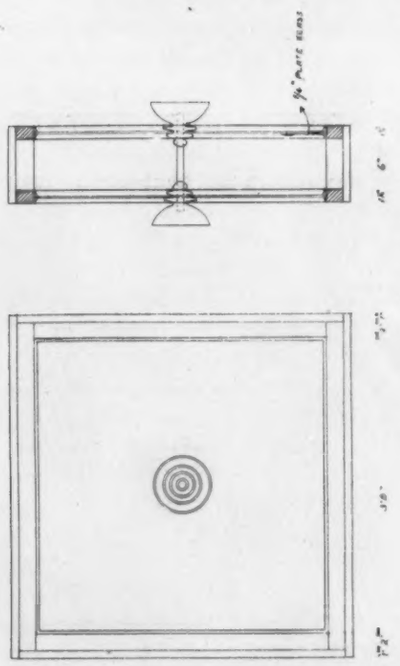
Oil that is specially refined for this high voltage work is mostly relied upon to effect adequate insulation. The spaces between the high voltage coils and all other parts are, however, subdivided into separate ducts by diaphragms of solid insulation, so that any conducting particle that by accident might fall into the oil can bridge only a small percentage of the oil space. Obviously this construction also subdivides the solid insulation into thin layers, so that any heat that might be generated in it from dielectric hysteresis will be promptly dissipated by the free movement of the oil in the ducts. The transformer case and cover, including all bushings and cables, are made with air tight joints. Previous to filling the transformer case with oil it is exhausted of all air that it contains by the use of a vacuum pump, and the winding is heated to expel any moisture which might be on the surfaces of the coils, and it is while in this vacuous condition that the oil, which has been specially treated to expel all foreign particles, air and moisture, is allowed to flow into the transformer from the oil-treating tank. Not only is this proceedure followed while the transformers are under test in the factory, but the same method of filling was repeated when the transformers were set up for commercial operation in Butte. By the use of these novel methods, the insulating quality of commercial oil is so improved as to require much less thickness of oil to withstand these high voltages than would otherwise be the case.

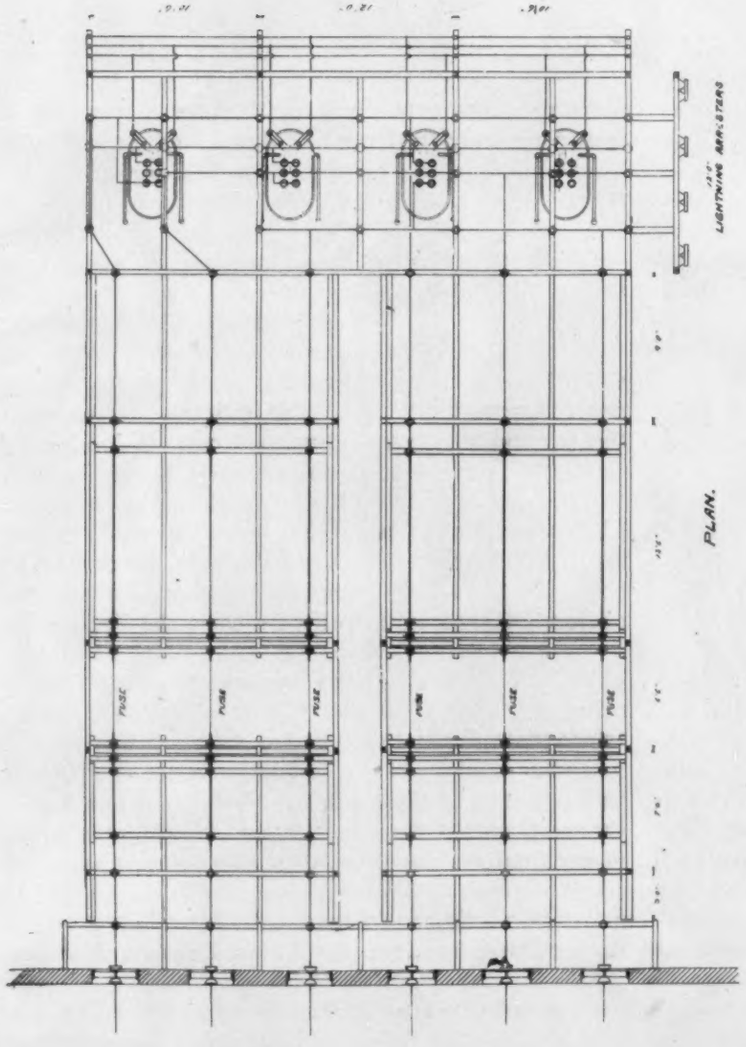
Factory tests showed that these transformers gave the following results when operated at sixty cycles, which is the frequency of the Madison River-Butte transmission: Efficiency, 97.5 per cent., regulation, 1 per cent., reactance, 4 per cent., heating by resistance, 30 degrees Centigrade. When the small capacity and high voltage of the transformers are considered, together with the fact that the greatest reliability rather than extreme efficiency, etc., was especially sought for, these figures prove that 80,000-volt transformers are an assured commercial success. The test included an insulation test at double the working voltage, namely, at 160,000 volts, which failed to develop any weakness.

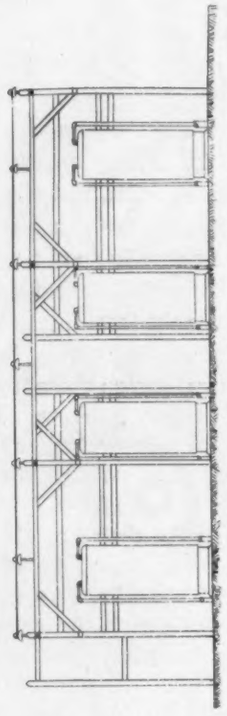
Further interesting tests were also given. To determine the possible presence of losses due to dielectric hysteresis through the oil or other insulation at the very high voltage at which the transformers were to operate, they were excited at double the normal voltage on their low potential sides and the losses were then measured with the high potential windings separated into several sections, so that the maximum voltage generated was so low that no such losses would take place. The high potential windings were then connected in series and the losses again measured, whereupon they were found to be identical with those first observed, thus indicating the entire absence of any such losses.

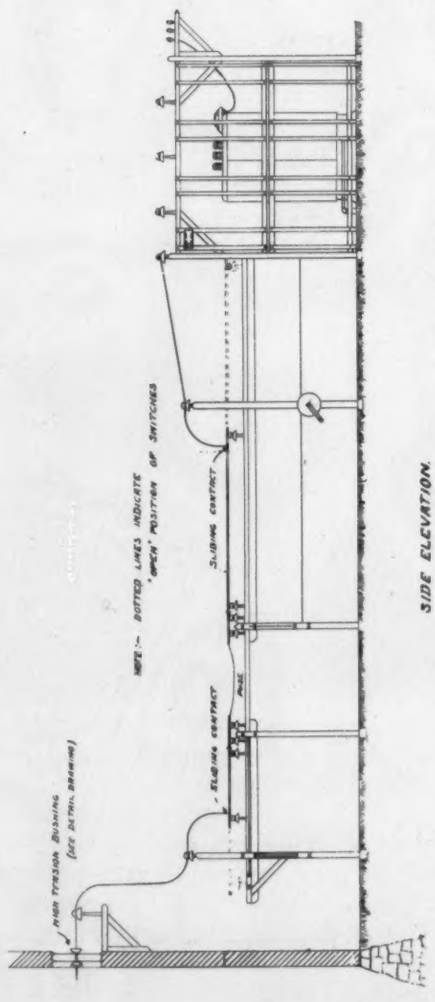
The terminal cables have soft rubber discs projecting from them, for it was found that this construction was necessary in order to break up the static charges which took place over the surface of the insulations when the transformers were under a strain of 100,000 volts between the windings and ground. The insulation of these cables is sufficient to withstand these strains alone, but the static charge on the surfaces was so heavy as to reduce the effective length of the insulation to but a small fraction of the actual length. Indeed, before the soft rubber discs were added, the test potential would cause an arc to form between the uninsulated end of the cable and the transformer case. The rubber was so molded that it could be securely cemented on to the insulated cable for the distance of an inch or more, and the disc, therefore, served the purpose of breaking the continuity of the static discharge and thus preventing short circuiting when under test voltage. When operating under 80,000 volts there was no brush discharge whatever, and obviously there is no necessity for using the discs except in connection with the test.

As a consequence of the fire which gutted the old Silver Bow plant of the Butte General Electric Company (since succeeded by the Butte Lighting and Power Company) on April 5th, 1899, and in further consequence of the rebuilding of the entire system in conjunction with the completion of the power transmission of 4000 horsepower from the Big Hole River into Butte in 1900, the Butte Lighting and Power Company did not find it necessary to rebuild and utilize the old Silver Bow station in its work of reconstruction. The boiler room was uninjured by the fire and its contents were removed and it was converted into an armature winding and repair shop









ARRANGEMENT OF 80,000-VOLT SWITCHES AND FUSES, BUTTE LIGHTING AND POWER COMPANY, BUTTE, MONTANA

as stated. Only the four brick walls of the engine and dynamo room remained, however, and it was not until the contract was entered into under which the Butte Lighting and Power Company became the consumer of power from the Madison River Power Company's transmission line that the Silver Bow station was again pressed into service. The walls were reinforced as necessary, a wooden truss and composition roof were erected, and a concrete floor was laid throughout, thus making the building one which was well adapted for substation purposes.

A clear idea of the design and character of the building and its unusual contents is conveyed in the accompanying plans and illustrations. The line wires, which are six in number, in two, three-phase circuits, enter the building through the rear or easterly end by means of high tension plate glass bushings which are of an original and very effective type. As shown in the accompanying detail drawing, a wooden casing contains a piece of plate glass which is thirty inches square and one-quarter inch in thickness. Two such casings and glass plates are set into the brick wall of the station in the manner appearing in the side elevation plan and in the center of each glass plate is cut a hole approximately four inches in diameter into which is set a "Provo" No. 2 glass insulator from which the cap or top piece has been broken off. The bell or petticoats of these insulators flare outwardly after the manner indicated in the detail drawing, and to complete the bushing a glass tube is cemented into the openings that have been made axially through the centers of the insulators. The bushing is thus made proof against every trouble which it is believed could possibly occur, and when the rigorous climate of Montana during the winter months is remembered, the advantage, not to say necessity, of some such device will be apparent. The lines run loosely through these window tubes, so to speak, but they are supported on pins and insulators placed immediately within and without the point of passage.

From the glass bushing the lines are carried down in graceful curves through one-quarter inch iron piping that is supported in standard insulators, to a sliding contact which rubs against a copper rod, five feet in length that is secured to wooden framework, through standard glass insulators. This rod forms the clip of the first high tension break switch, for its point closes into a stationary socket which forms the terminal of a similar rod, two feet in length, from the further end of which is suspended horizontally a high tension fuse. The fuses used are of stranded aluminum, five feet in length and covered with a thick woven tube of fibrous material well impregnated with fireproof compounds. In line with these rods, as shown in the side elevation of the switch, is the second stationary socket, immediately after which is high tension break, similar in construction to the first but having a length of eleven feet six inches, and upon the second sliding rod bears the sliding contact which carries the current to the transformer.

There are six sets of switches similar to the single one just described, and the arrangement of them is admirably shown in the accompanying ground plan. All is supported in wooden rackwork, made of filled and finished timber and occupying a width of thirty-three feet by a length of forty feet, while an extension of the structure for sixteen feet lengthwise furnishes a rack for the support of the high and low tension pins and insulators. The framework on which are mounted the various rods that bear against the sliding contacts are connected by cotton rope to two sets of windlasses so that the operation of any windlass in one direction or the other will open or close the respective set of switches which the windlass is designed to operate. Thus it is that either line of either circuit may be broken in two places, namely either before or after the fuse. If broken before the line reaches the fuse, an air gap of three feet six inches may be given, whereas if the switch beyond the fuse from the line, or in other words, if the switch nearer the transformer is opened, an air gap of ten feet can be had, making the total air gap of the two switches to be thirteen feet six inches, which is believed to be sufficient to break any load or any potential that may be met in commercial service.

It should be explained further that these switches are worked in sets of three, that is each set (of which there are two) breaks the three legs of its respective transmission line, and that each such line may be broken by either one of the two sets—or both of them—which are cut into that particular line. If re-fusing becomes necessary, the circuit is opened on each side of the broken fuse, which renders it dead and makes re-fusing a perfectly safe operation. The paralleling of the lines is accomplished by means of the high tension busses directly over the transformers and by means of which, in conjunction with the proper manipulation of the switches, either line may be thrown on to the transformers. The lightning arrester equipment possesses no unusual features, being of the ordinary Wirt type as manufactured by the General Electric Company. Its location is shown in the half-tone on page 164.

As yet the heaviest arc that has been drawn out through the pulling of the switch either experimentally or in actual service, has been broken by the upward movement of the arc before the switch terminals have been separated three feet, and this marks the performance of the switch when carrying 1000 horsepower at 40,000 volts. It is further interesting to watch the behavior of the arc when, with a pressure of 40,000 volts on the line, it is opened slowly during a time when the transformers are under excitation but are carrying no load. The arc waves up its ragged, wavering Λ-shape until the switch points have been separated ten or twelve inches, when it breaks. And even with the ten-foot switch open and with no capacity beyond the smaller switch except that of the fuse and four feet of switch rods forming the sockets on each side of the fuse, the arc will hang on in a thin thread until a separation of three or four inches causes it to break.

The Journal of ELECTRICITY POWER and GAS
DEVOTED TO THE CONVERSION, TRANSMISSION and DISTRIBUTION OF ENERGY.

PUBLISHED MONTHLY BY
THE JOURNAL OF ELECTRICITY PUBLISHING COMPANY
144 Union Square Avenue, San Francisco, Cal.
Telephone Bush 519.

Official Organ of the Pacific Coast Electric Transmission Association.

Yearly subscription: Domestic, $2.00; Foreign, $2.50; Single Copies, 25 cents.
Subscriptions can not be begun with back numbers.
Manuscripts to be returned if rejected must be accompanied by return postage.

Notice to Publishers
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Entered as second-class matter at the San Francisco Post Office, August 15, 1899.
Entered as *The Electrical Journal*, July, 1895. Entry changed to *The Journal of Electricity*, September, 1895.

VOLUME XIII MARCH, 1903 NUMBER 3

EDITORIAL.

A LEGAL DEPARTMENT.

It is with a great deal of satisfaction that announcement is made of the completion of arrangements whereunder Mr. Frank P. Medina, who is well known to the electrical engineering fraternity of the Pacific Coast, becomes a collaborator of the editor of THE JOURNAL in the preparation and publication of a series of articles to appear in these columns as a special department devoted to the law of electricity. Of all the legal talent on the Pacific Coast, if not in the entire West-of-Chicago, Mr. Medina is, so far as is known, the only practitioner who can lay just claim to entering the chosen branch of the profession of law understandingly. Being an electrical engineer of national repute, in telegraph circles at least, by reason of his inventions and achievements therein, and having mastered the technics of the science of electricity in all branches through dint of life-long study and application, and having been admitted to the practice of law before the bar of the Supreme Court of the State of California, he has gained knowledge and experience which have fitted him pre-eminently for specialization along the legal sides of electro-technical commercialism.

In the meantime let it be borne in mind that while the arrangement referred to will in no way be permitted to militate against the furtherance of Mr. Medina's interests regarding individual clientage, his services will be at the command of readers of THE JOURNAL, without charge, in the giving of opinions to appear in these columns in answer to inquiries from subscribers concerning legal matters of general interest to the power engineering industries which this publication represents. Inquiries along these lines are invited from subscribers, and the assurance is given that while the text of the inquiry and the legal opinion which it brings forth will be published in full, the name and identity of the inquirer will be withheld from publication, if desired.

INSPECTION IN SAN FRANCISCO.

From one confine of the Pacific Coast to the other the electric lighting and power industries of each important locality are serious in their endeavors to learn of the progress being made in other localities in the vital matter of electrical inspection. To such, a review of the system adopted in the city of the Golden Gate, proves that where the administration of the affairs of the municipality is well organized and ably executed, electrical inspection can be safely entrusted to municipal enactments. There was a time in San Francisco, when electrical construction went at a go-as-you-please gait and, in the expression of our English cousins, "jerry" wiring methods luxuriated until finally in a vital effort at self-preservation the local lighting and power interests, although warring to the death between themselves, united in the work of bringing the municipality to a realization of the importance of the subject, and, having realized, it legislated with the full co-operation of the electric companies, and, therefore, wisely and well.

It is now some five years or more since the municipality of San Francisco became active in the administration of the electrical affairs of the city, and the evolution of the present admirable system of its Department of Electricity is full of interest. The new Charter placed the Department under the rules of the Civil Service Commission, which at once made a position in the Department of Electricity well worthy of serious effort in securing. As a result, coupled with the intelligent labors of a Board of Electrical Examiners of the Commission, its employees are technically competent and otherwise well qualified for the responsible positions which they hold. But, however competent they might be, their efforts were destined to be unavailing without wise laws to back them. As a result, there was first adopted Order No. 267 of the Board of Supervisors regarding inside wiring; then followed Ordinance No. 353, requiring the registration of wiremen and wiring concerns, after which there was enacted Ordinance No. 429 regarding the erection of pole lines. These ordinances are of sufficient interest to the electric lighting and power concerns of those portions of the country which suffer from the absence of electrical inspection, yet which are most anxious that it should be brought about in proper form to warrant digesting.

These municipal regulations are, as stated, three in number, and the following is a *verbatim* reproduction of them:

ELECTRICAL ORDINANCE, ORDER 267 (SECOND SERIES).

Providing for the placing of electrical wires, appliances and construction in buildings in the City and County of San Francisco.

The people of the City and County of San Francisco do ordain as follows:

SECTION 1. All electrical construction, all material and all appliances used in connection with electrical work, and the operation of all electrical apparatus in buildings in the City and County of San Francisco shall be in conformity with the rules and regulations set forth in what is known as the "National Electrical Code," being rules and requirements for the installation of electrical wiring and apparatus for electric light, heat and power, as the same are now established, and the said rules and regulations, together with any amendments and changes made therein from time to time, are hereby adopted and approved.

SECTION 2. Upon completion of the wiring of any building, it shall be the duty of the corporation, co-partnership or individual doing the same to notify the Superintendent of Fire Alarm and Police Telegraph, or the Chief of the Department of Electricity, who shall at once inspect the same, and, if approved by him, shall issue a certificate of satisfactory inspection, which shall contain the date of such inspection and an outline of the result of such examination; nor shall current be turned on such installation until said certificate be issued; nor shall any change, alteration or extension be made in the wiring of any building after inspection without notifying the said Superintendent or Chief, and securing a permit therefor.

SECTION 3. Any corporation, co-partnership or individual who shall fail, neglect or refuse to comply with the provisions of this order shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not more than one hundred dollars or be imprisoned not more than ninety days, or by both such fine and imprisonment.

SECTION 4. This order shall take effect and be in force from and after its passage.

Approved: San Francisco, December 29, 1899.

JAS. D. PHELAN,
Mayor and ex-officio President of the Board of Supervisors.

ORDINANCE NO. 352.

Providing regulations for the placing, installing and operating of electrical wires, appliances, apparatus or construction in or on buildings in the City and County of San Francisco.

Be it ordained by the people of the City and County of San Francisco as follows:

SECTION 1. Every corporation, co-partnership or individual engaged in conducting the business of placing, installing or operating electrical wires, appliances, apparatus or construction in or on buildings in the City and County of San Francisco, shall appear in person, or by a duly authorized representative, at the office of the Department of Electricity, and shall there register his name and place of business in said City and County, which act, upon being sworn, shall entitle him to a certificate of registration; *provided*, however, that no certificate of registration shall be granted for a period of more than one fiscal year or the unexpired portion thereof.

SECTION 2. It shall be unlawful for any corporation, co-partnership or individual to engage in conducting the business of placing, installing or operating electrical wires, appliances, apparatus or construction in or on buildings in the City and County of San Francisco without first obtaining a certificate of registration from the Department of Electricity, and said certificate must be renewed, as provided for in Section 1 of this order, within thirty days after the first day of July of each fiscal year.

SECTION 3. The placing, installing or operating of electrical wires, appliances, apparatus or construction in or on buildings in the City and County of San Francisco, shall be executed in accordance with plans and specifications previously approved in writing by the Chief of the Department of Electricity of said City and County; *provided*, however, that a copy of said plans and specifications as approved shall be placed on file in the office of the Department of Electricity.

SECTION 4. Every corporation, co-partnership or individual engaged in conducting the business of placing, installing or operating electrical wires, appliances, apparatus or construction in or on buildings in the City and County of San Francisco, before registration, shall give a bond to the State of California in the sum of five hundred dollars ($500.00), with good and sufficient surety, for the faithful compliance with the provisions of this ordinance, and said bond shall be approved by and filed with the Chief of the Department of Electricity.

SECTION 5. The failure, neglect or refusal on the part of any corporation, co-partnership or individual, after due notification by the Department of Electricity, to correct, obviate or remove any fault, error or deficiency in placing, installing or operating electrical wires, appliances, apparatus or construction in or on buildings in said City and County shall be deemed sufficient cause for the Chief of the Department of Electricity, and he is hereby authorized, to suspend said certificate of registration for a period of not exceeding thirty days.

SECTION 6. Any corporation, co-partnership or individual who shall continue to fail, neglect or refuse to comply with the provisions of this order shall be deemed guilty of misdemeanor, and upon conviction thereof shall be fined not more than one hundred dollars ($100.00) or be imprisoned not more than ninety days, or by both such fine and imprisonment.

SECTION 7. This order shall take effect and be in force on and after its passage.

In Board of Supervisors, San Francisco.
Passed: September 3, 1901.

Approved: San Francisco, September 5, 1901.

BILL NO. 500.

ORDINANCE NO. 429.

An ordinance regulating the placing, installing, operating and maintainance of poles and electrical wires, appliances, apparatus or construction in or on streets and sidewalks of the City and County of San Francisco.

Be it ordained by the people of the City and County of San Francisco as follows:

SECTION 1. It shall be unlawful for any person, firm or corporation to erect any pole on the streets or sidewalks of the City and County of San Francisco unless it be painted with suitable material to the satisfaction of the Board of Public Works. It shall be unlawful to maintain such poles unless they be painted with suitable material to the satisfaction of the Board of Public Works.

SECTION 2. It shall be unlawful to erect or maintain any pole on the streets or sidewalks of San Francisco which is situated nearer than ten (10) feet to a pole on which is supported a lamp maintained by the City and County for lighting the public streets unless permission in writing is first given by the Chief of the Department of Electricity; nor shall any other pole be erected in or on the streets or sidewalks of the said City and County unless permission in writing is first given by the Chief of the Department of Electricity.

SECTION 3. The placing, installing, operating or maintenance of electrical wires, appliances, apparatus or construction in or on streets or sidewalks in the City and County of San Francisco shall be executed in accordance with plans and specifications previously approved in writing by the Chief of the Department of Electricity of said City and County; *provided*, however, that a copy of said plans and specifications as approved shall be placed on file in the office of the Department of Electricity.

SECTION 4. Nothing herein contained shall be deemed to authorize any person, firm or corporation to erect any pole on any street or sidewalk within the City and County without permission first obtained under existing laws.

SECTION 5. Any person, firm or corporation violating any of the provisions of this ordinance shall be guilty of a misdemeanor, and upon conviction thereof shall be fined not more than five hundred ($500.00) dollars, or be imprisoned not more than six (6) months.

SECTION 6. This ordinance shall go into effect immediately.

THE BUTTE COUNTY GAS AND ELECTRIC SYSTEMS.*

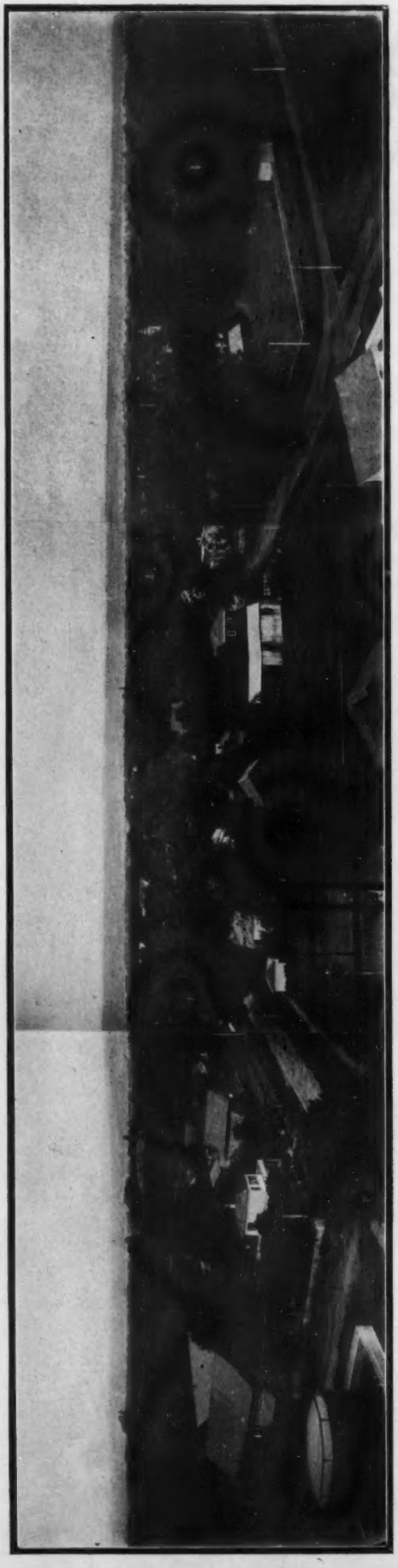
BUTTE County, which is one of the chief agricultural and horticultural counties of the State of California occupies a position in the northeast portion of the Sacramento Valley, bounded on the west by the Sacramento River and on the east by the summit of the westerly range of the Sierra Nevada Mountains. Its total area is approximately 1730 square miles, or somewhat larger than the State of Rhode Island. One-half of the whole may be properly termed foothill lands, and of the remainder one-fifth may be dominated as mountainous, leaving about one-third of the entire area as fertile valley or agricultural lands. The mountains are heavily timbered, giving place to important lumbering interests; the foothills are covered with oak and smaller growth, while the valleys lands have, with the exception of the adobe soil, splendid growths of mammoth oaks. The county is so situated that it has all the advantages of cheap and ready transportation. The Sacramento River along its western boundary affords communication by water for the passage of vessels at all times of the year, while the California and Oregon Railway traverses the center to the county its entire length; a branch of the same line extends to Oroville from Marysville, thus giving all the more important parts of the county ready communication with the markets of the coast and the seaport at San Francisco.

The climate of the county is similar to that of all interior parts of California, with the exception that its situation near the Sierra Nevada Mountains induces a more abundant rainfall than have many of the other interior counties, thus rendering a failure of crops practically unknown, and reducing the expense of farming and fruit growing to a minimum, because of the absence of irrigation requirements. In the higher parts of the county during the winter months some snow falls—just enough to insure to the numerous streams crossing its area living water during the long summers. In the foothills the climate is more delightful. No snow falls and frost comes but seldom. Warm summer days are tempered by cool nights and everything is propitious for the luxuriant growth of all plant life. In the valley the climate is but a modification of that of the foothills—long rainless summers, giving opportunity for the garnering of the grain and the curing of the fruit. In September the rains begin, and from then until May are of frequent occurrance, so interspersed with faultless spring-like days, as to give to all vegetation the moisture needed and not so plentiful that damage accrues. Frosts come infrequently, and until the rainless summer begins hill and dale are covered with verdure, giving sustenance to the herds of sheep and cattle that find grazing places and their sole food thereon. As before stated the rainfall is abundant and a "dry" year is unknown. It varies from about an average of twenty-five inches per annum in the valley to considerably more in the foothills and mountains.

Irrigation is not generally practiced in the growing of fruit or grain, except citrus fruits, but should it be deemed advisable in the future, no county in the State possesses the natural facilities that Butte does. The great Sacramento River runs along its boundary, while in the eastern section the Feather River bisects the county with enough water to irrigate the whole of the lands that are adapted to fruit; Butte Creek, another large stream, runs through its center, while Big Chico, Pine, Mud and numerous smaller, but never failing creeks, run through thousands of acres of its most fertile lands. But without these supplies nature has provided in the valley portions immense subterranean reservoirs, easily accessible by shallow wells of from twelve to twenty feet, which countless pumps can never exhaust nor lower. With the cheap power which the county now possesses through its electric power transmission service, the irrigation of all its lands adapted to fruit, stock, or garden uses is no longer a problem of any consequence. In the eastern section of the county, where orange and olive growing has assumed great proportions, irrigation is very generally practiced and shortage of water is never known. Many of the irrigating canals were originally built for mining purposes, but with the passing of their utility as such they have been converted into irrigating ditches, so that now ditch properties within the county aggregate a length of practically 300 miles, of which the South Feather Water and Union Mining Company has forty-two miles, the Palermo Land and Water Company has forty-four miles, the Cherokee Mining Company has fifty miles, the Oroville Water Company has thirty-three miles and the balance of the aggregate length given consists in private ditches.

Until recently, however, the gas and electrical industries of the county were really inconsequential, being confined, as they were, to the needs of the single city of Chico, with its population of some 5000 people. Four or five brief years have, however, wrought wondrous changes in the situation, for now modern business and engineering methods prevail in Chico and throughout its tributary country, a sizeable transmission plant has been built on Butte Creek primarily for supplying power for the operation of lighting and power service in Chico, and secondarily for the operation of the gold dredges of the Feather River district. Then came an era of extension which resulted in the building of the transmission circuits southward through Biggs and Gridley into the city of Colusa, the county seat of Colusa County.

*Being the second of the series of articles to be published describing the local properties of the great systems of the California Gas and Electric Corporation.

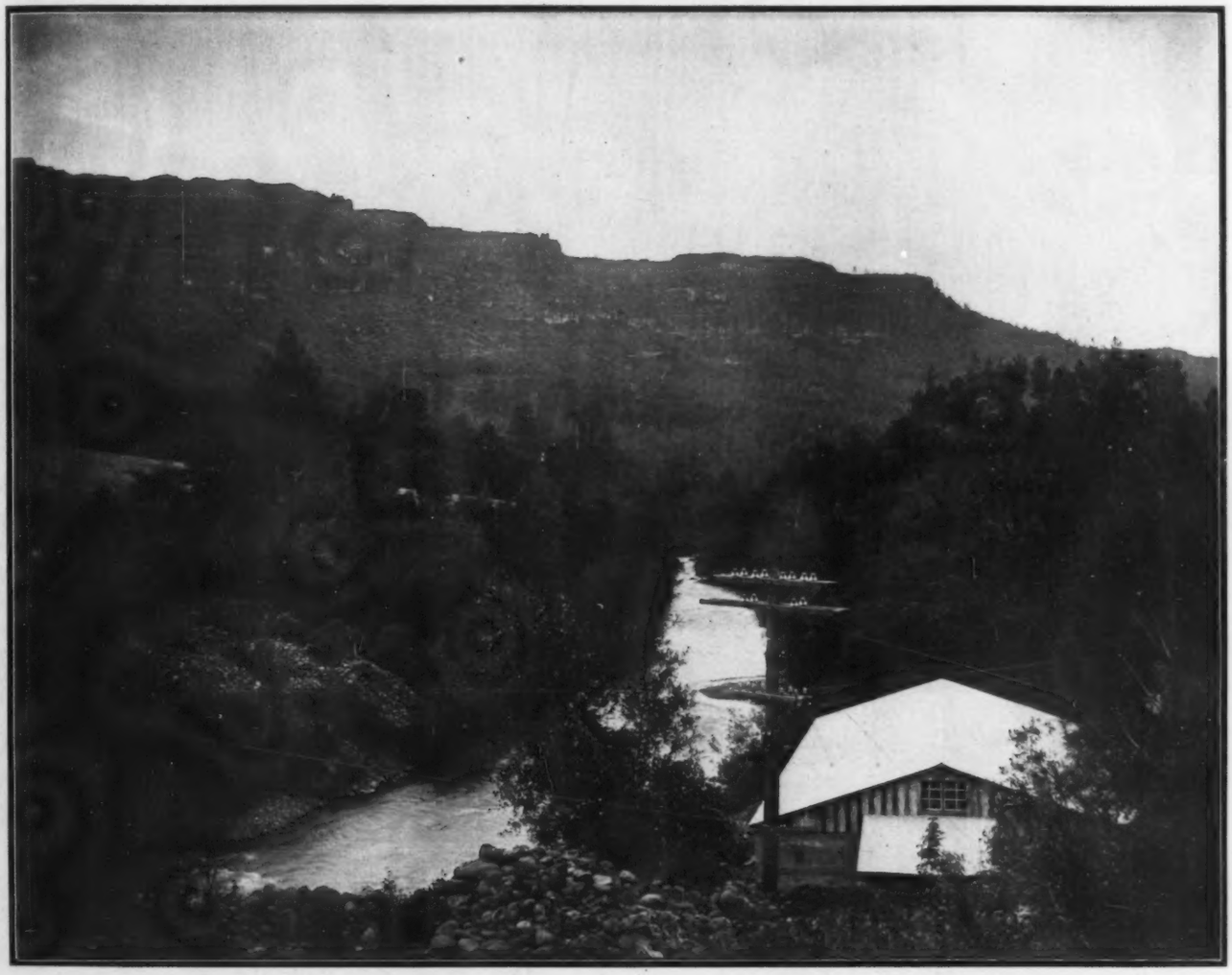


PANORAMIC VIEW OF THE CITY OF CHICO, CAL., FROM THE WATERWORKS TOWER

Next the favorable commercial possibilities of Butte County, and specially the possibilities of the development of enormous amounts of power from its unfailing mountain streams, resulted in the acquirement of its gas and electric industries by the Valley Counties Power Company, which has already begun actively the development of hydraulic work of a magnitude that is without parallel in the entire West. Before long, then, Butte County will be more famous in engineering circles than is the Colgate power house today.

The enormous installation which the Valley Counties Power Company is now installing in Butte County is of such a character that it must be described in a separate edition which will be forthcoming in these columns in due season, but so great and far-reaching is the work now in hand—the initial undertaking of which is in progress at Nimshew—that no more than passing reference to it can be made at the present time. Indeed, the bulk of the projected water power development of the California Gas and Electric Corporation is located in Butte County, and it need not be surprising if the present decade should witness the development and utilization in transmission purposes of at least 100,000 horsepower from its water courses.

For the present, as stated, the description of the electrical industries of Butte County must, perforce, exclude further references than those made to the great work now in progress at Nimshew, as well as that of further work in progress or in contemplation.



PANORAMIC VIEW OF THE CITY OF CHICO, CAL., FROM THE WATERWORKS TOWER

THE BUTTE CREEK POWER HOUSE AND SURROUNDINGS

THE CHICO GAS COMPANY.

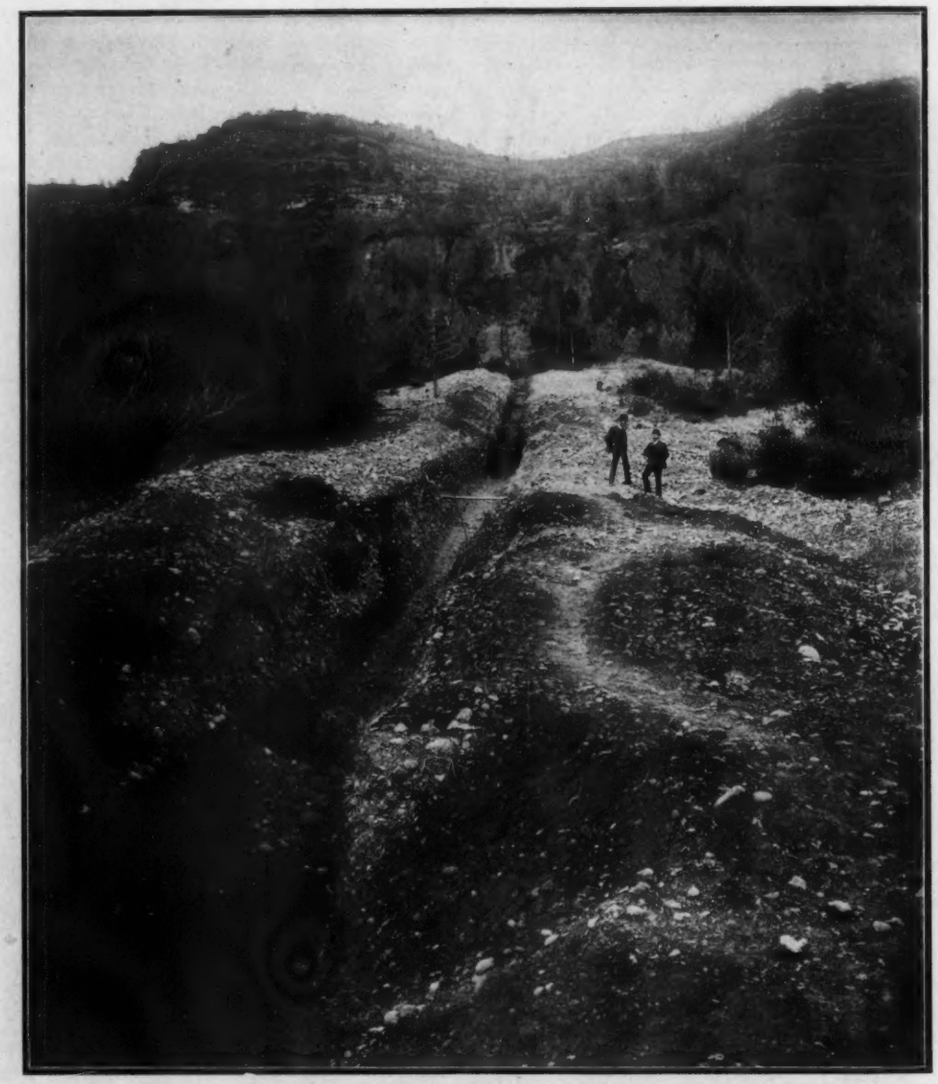
Gas was first made in Chico some two years prior to the organization of the Chico Gas Company, or to be more exact, it was in the autumn of 1872, the distribution being effected through wooden pipes in a very limited section of the city. Gasolene gas was made at first in benches consisting of three round iron retorts, each four inches in diameter and seven feet in length and this gas, which had an average illuminating value of eighteen candlepower, was sold at $6.00 per thousand cubic feet. Afterward the gasolene plant was abandoned and oil gas was made and delivered direct to the holder at a pressure of five inches of water, but it is recorded of this oil plant* that it "made more lamp black and oil tar than gas." But to revert to the earlier period of the company's existance, it was organized on December 8, 1874, and incorporated as the Chico Gas Company on December 19th of the same year, its first officers being Messrs. A. Bullard, president and treasurer; George F. Nourse, vice-president; C. L. Stilson, secretary, and N. P. Fuller, superintendent, and these gentlemen, together with Messrs. J. W. Gilkyson, John E. Ager and L. A. Kelley, constituted the first board of directors. There were originally but three stockholders in addition to the names already given, and they were Messrs. George W. Dorn, E. Rose and H. C. Copeland. Various changes occurred in the personnel of the company throughout the years which intervened before its absorption by the Chico Gas and Elec-

*"The Gas Companies of the Pacific Coast," page 11.

tric Company, at which time its principal officials were Messrs. F. C. Lusk, president, and A. G. Simpson, secretary—to the latter the writer expresses indebtedness for information given.

As may have been inferred, oil gas was not more a success in Chico than it had been anywhere else, and accordingly it was abandoned some ten years ago and a coal gas plant was installed, which was in turn, displaced by a water gas plant in 1898. Then, finally, after the acquirement of the Chico Gas and Electric Company by its present owners in 1900, the present crude oil-water gas plant was installed because of the cheapness of oil and the advantages in point of economy possessed by the system named. Twenty-three candle gas is produced and it is of most excellent quality in every respect. Its use is considerably greater as a fuel than as an illuminant, the rates being $1.80 per thousand when used for cooking and heating purposes, and $2.00 per thousand when used for lighting purposes.

Electricity was introduced by the Chico Gas Company for arc and incandescent electric lighting purposes in 1889, the machines used being small ones of the Weston and Westinghouse alternator type respectively, but as only a desultory interest was taken in the development of the electrical end of the business, it never amounted to much more than an apparent safeguard against competition. Eventually, however, the electric plant proved to be unavailing even in its scarecrow capacity, for in 1898 the Butte County Electric Power Company was formed for the purpose of developing the water power of Butte Creek at a point about fourteen miles southeast by east of Chico, and transmitting it to various points roundabout, among which was Chico. This was the beginning of the end of the Chico Gas Company, for it was, as stated, absorbed by the Chico Gas and Electric Company in 1900. All the stock of the latter corporation is owned by the California Central Gas and Electric Company which has, in turn, passed into the control of the California Gas and Electric Corporation within the present year. On the other hand, the Butte County Electric Power Company was transferred to the ownership of the Valley Counties Power Company on March 1st, 1902, the latter being a sub-company of the Bay Counties Power Company, and having been along with it merged into the system of the California Gas and Electric Corporation within the last few months. Thus it is that the last named corporation has acquired the ownership of both the gas and electric systems operating in Chico and thereabouts.

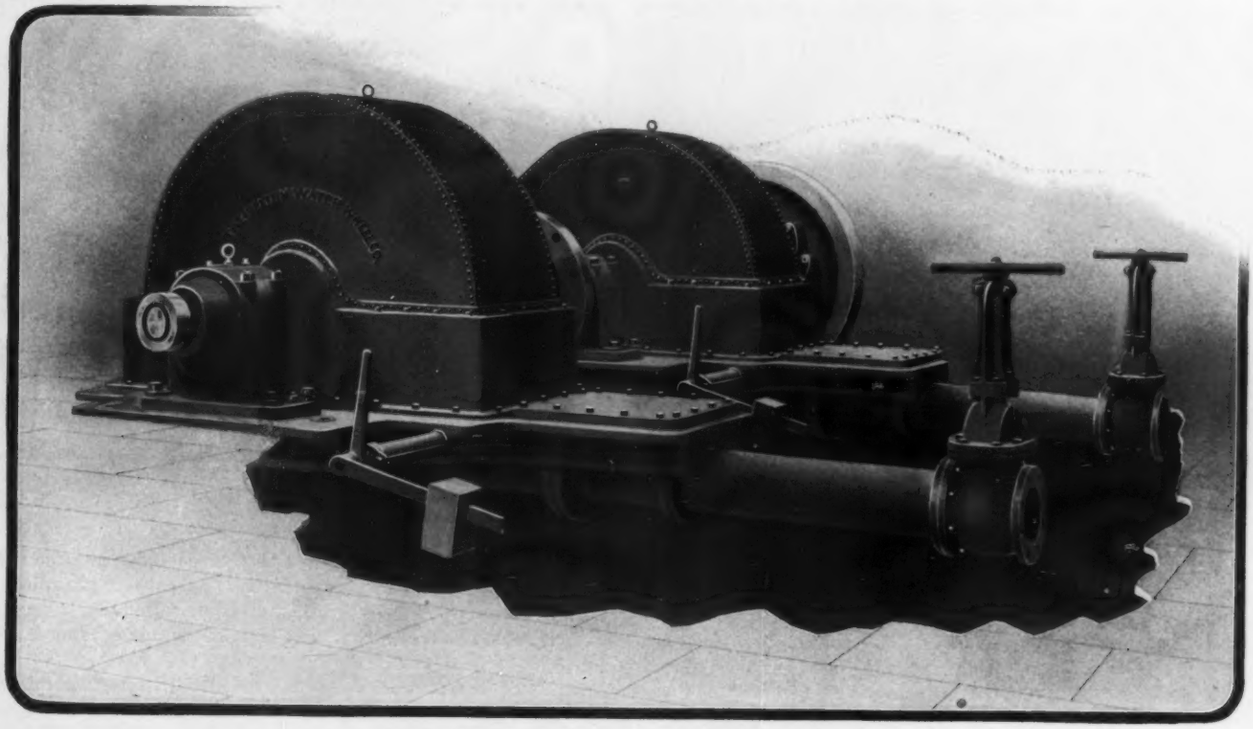


LOOKING UP THE TRENCH FOR THE SECOND PIPE LINE OF THE BUTTE COUNTY PLANT

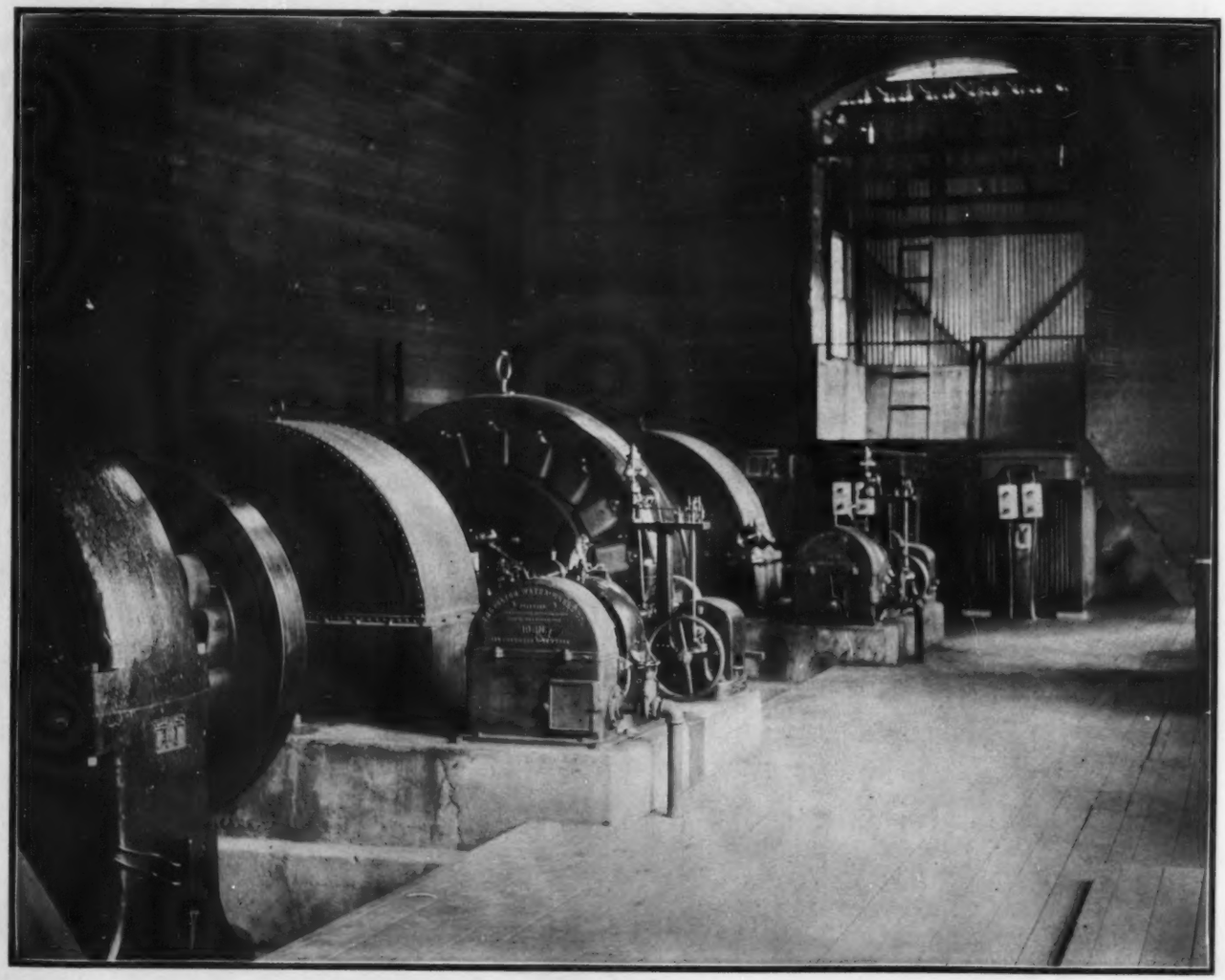
THE BUTTE COUNTY ELECTRIC POWER COMPANY.

The Butte County Electric Power Company owed its inception to Mr. A. F. Johns, who recognized the value of the water power of a ditch that had been abandoned by the Bostwick Gold Mining Company in 1887. This had a capacity of about 3000 miners inches, and the water it carried was taken from Butte Creek at a point about eight miles by way of the stream above the present power house and carried along the canyon side through eight and three-fourths miles of canal and one and one-half miles of flume, so as to give a static head of practically 600 feet at the point where it was proposed to locate the power house. Then 2600 feet of pipe line would enable the generation of some 2500 horsepower for transmission to Chico, Colusa, Oroville and the great gold dredging industries of the Feather River.

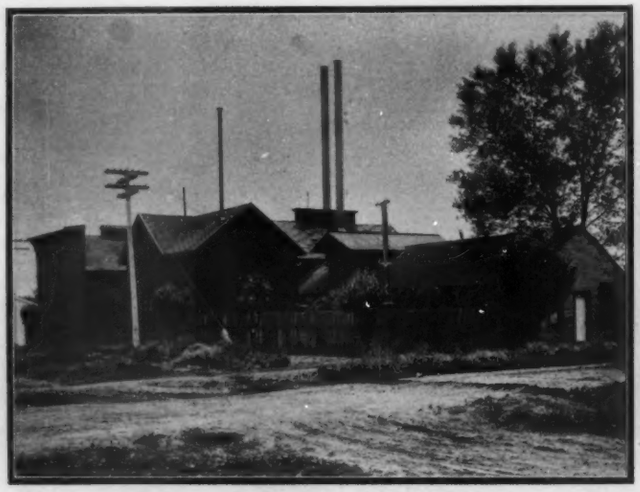
This was, in general terms, the basis upon which the Butte County Electric Power Company was organized, its original directors being the late O. W. Meysenburg, Judge J. A. Waymire, and Messrs. S. C. Dennison, H. B. Snow and C. C. Jones. The company was incorporated in 1898, and at once began the work of construction, which was prosecuted 'eisurely until finally the plant was completed with a transmission line to Chico and the Feather River in May; 1900, the entire investment to that time representing about $175,000. In February, 1900, prior to the absorption of the Butte County Electric Power Company, its directory consisted of Messrs. Meysenburg, Dennison and Waymire, before named, together with Messrs. H. W. Heath and Park Henshaw, the latter having become heavily interested in the company and being its president. No material change was made from the details of the hydraulic system as above outlined, with the exception that the canal and flume line was overhauled as necessary. The penstock is at an elevation of 1600 feet above sea level, and a twenty-four-inch pipe line was laid therefrom to the power house, which was



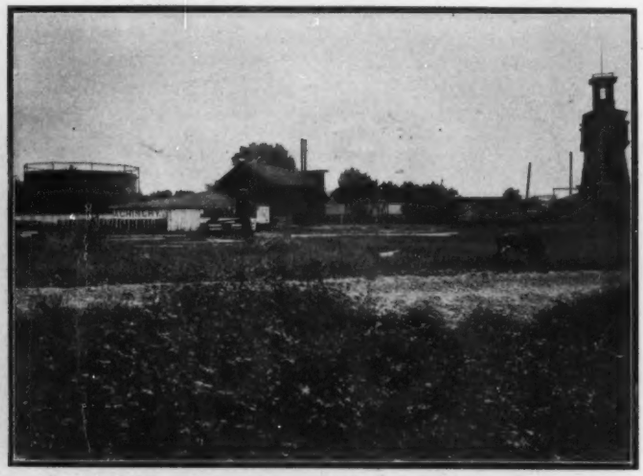
THE PELTON WATER WHEEL UNITS IN BUTTE CREEK POWER HOUSE



ORIGINAL SECTION OF THE POWER HOUSE OF THE BUTTE COUNTY ELECTRIC POWER COMPANY



THE ABANDONED STEAM PLANT AND THE BRICK SUBSTATION AT CHICO

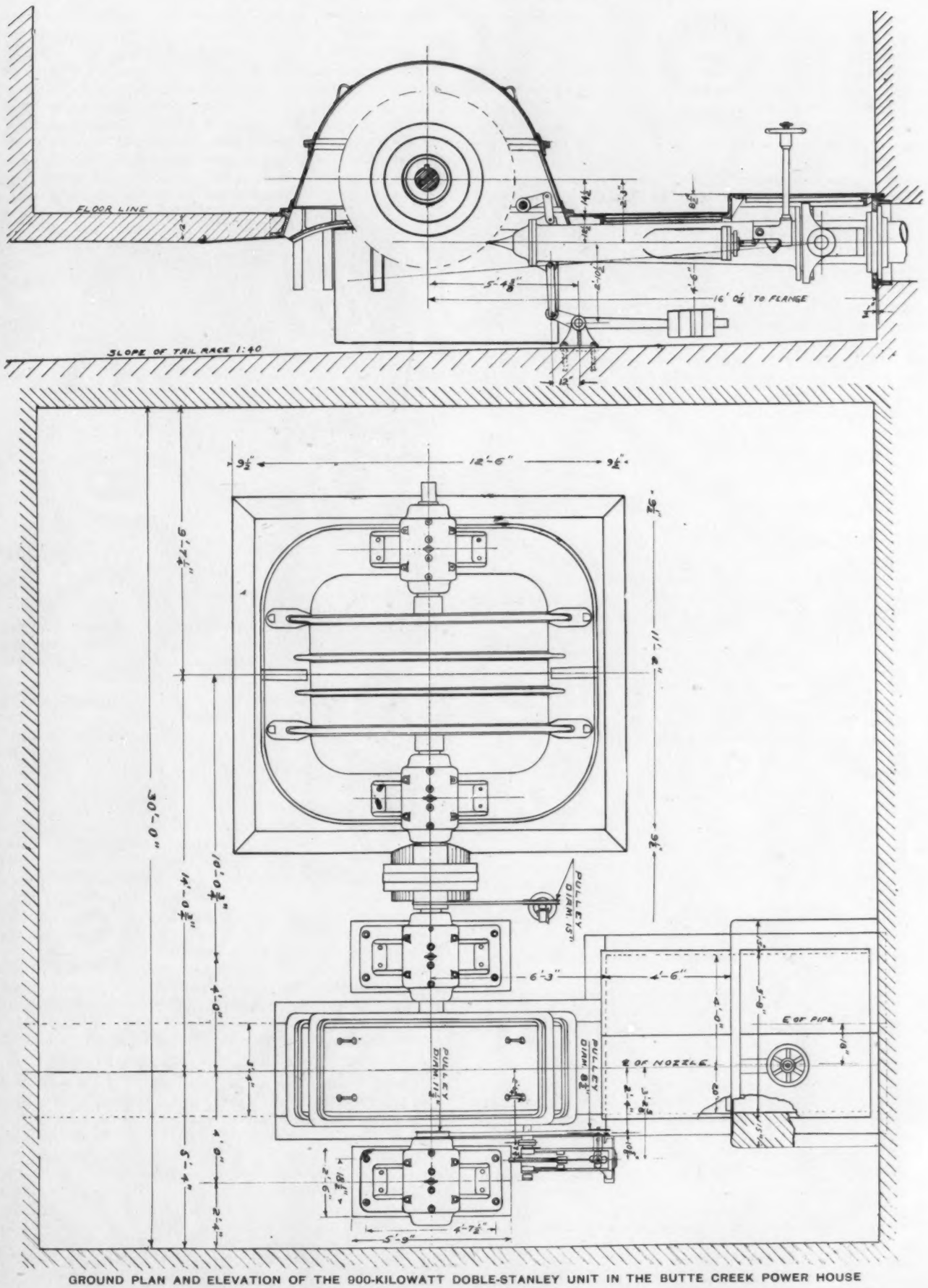


THE WATER WORKS TOWER OVERTOPS THR CHICO GAS WORKS

equipped with two sets of single Pelton water wheels each having a diameter of fifty-eight inches and running at 400 revolutions per minute. The mounting of these wheels, as shown in the accompanying illustration, presents a typical example of the semi-masonry type of hydraulic installation. Direct connected to each of these wheels is a 400-kilowatt Westinghouse Y-connected three-phase generator delivering sixty cycle current at 2400 volts to a bank of three 150-kilowatt oil-insulated air-cooled transformers by means of which the generator potential is raised to 16,500 volts for transmission purposes. A fourth transformer of similar type and capacity is held in reserve. The line is run with a grounded neutral.

As stated heretofore, the plant started with two transmission lines in operation. The first of these was carried to Chico a dis-

INTERIOR OF THE OFFICE OF THE CHICO GAS AND ELECTRIC COMPANY



GROUND PLAN AND ELEVATION OF THE 900-KILOWATT DOBLE-STANLEY UNIT IN THE BUTTE CREEK POWER HOUSE

tance of fourteen miles, and the second line was run in a southernly direction to Oroville and the Feather River gold dredging district near by. This latter line is approximately thirty-two miles in length, so the over all length of line was then forty-six miles. In August, 1901, however, the line entering Chico was continued on to Colusa, passing Gridley en route. The distance by way of the pole line from Chico to Colusa is forty miles, making the Colusa line to be seventy-two miles long. In the meantime an independent pole line circuit had been run from the power house to a junction with the Chico-Colusa line, so that now three main pole line circuits emanate from the Butte Creek power house, namely, the Chico, the "Junction" and Oroville lines. These main lines are of copper throughout. The Chico and Colusa lines are each of No. 6 B. & S. gage medium hard drawn, but an aluminum cable of No. 2 B. & S. gage is used for the dredger circuit near Oroville. The telephone lines are placed on cross-arms on the main pole lines and are transposed every ten poles, but the transposition of the power lines is restricted to a single transposition in each main line, that is, one complete transposition in the Oroville line, one in the Chico line and one midway between the power house and the junction made with the Chico line and the Colusa line. At the time of the absorption of the Butte County Electric Power Company by the Valley Counties Power Company the Butte Creek plant was delivering 400 kilowatts to Chico through two 200-kilowatt transformers, 150 kilowatts to Gridley through two seventy-five-kilowatt transformers, 100 kilowatts to Colusa through two fifty-kilowatt transformers, and about 500 mechanical horsepower to the dredgers along the Feather River country.

Material enlargements of the plant of the Butte County Electric Power Company had been projected prior to its absorption by the Valley Counties Power Company, but these were not entered into until after the company had become a part of the Bay Counties system. Then the first effected was in the installation of a second twenty-four-inch pipe line at the Butte Creek power house, giving water for the operation of a Pelton type wheel for driving an 800-kilowatt Stanley generator, which delivers three-phase current at 2400 volts. Three Stanley oil-insulated water-cooled transformers of an aggregate corresponding capacity were installed, the Oroville line was joined at the Oroville substation of the Bay Counties Power Company to the line of the latter company which has already been running northerly from the Colgate power house into the Oroville district, and thus the Butte Creek system became united with the great Bay Counties system. A further project of the Butte County company prior to its absorption consisted in its acquirement of the water rights of the old Cherokee ditch, in which some 3000 miners inches of water was available for power purposes at a head of 1600 feet. Moreover it was planned that an additional head of 600 feet should be added to the Butte Creek plant to utilize additional water that remained in the creek, and these increments would have given the Butte County transmission a power house capacity of 17,500 horsepower.

As to the water wheels, the original installation consists of two Pelton units, each of which is direct-connected to a Westinghouse 500-volt, 400-kilowatt, three-phase generator, running at 400 revolutions per minute, and each wheel consists of a disc center, with cast steel buckets mounted on a hammered steel shaft. The water impinges on the wheels, which have a diameter of fifty-eight inches, by means of deflecting single nozzle that are controlled by means of Pelton electric governors, while directly back of the deflecting nozzles are gate valves of the Pelton single disc type with outside yokes, screws, and rising spindles. The shafts are supported by automatic ring oiling journal stands of the standard Pelton type, and wheels are completely enclosed in upper and lower steel housings, all being mounted on heavy cast iron floor plates let into masonry foundations. Direct connection is obtained by means of flexible leather link fly wheel couplings, each weighing 5000 pounds. The exciter units have a capacity of seventy-five kilowatts each and are direct-driven by independent small Pelton wheels.

Immediately after the acquisition of the plant of the Butte Creek Power Company by the Valley Counties Power Company, the new owners decided to at once increase its capacity, which was done with the least possible delay. A Stanley "Type 22" inductor generator, which is a counterpart of the smaller units that have been in operation for over three years in the Colgate power house of the Bay Counties Power Company, was installed. This generator has a rated capacity of 900 kilowatts, and is of the three-phase, sixty-cycle variety, delivering 2400 volts and running at a speed of 360 revolutions per minute. It is of the two-bearing type,

DOBLE WHEEL HOUSING IN THE BUTTE CREEK POWER HOUSE

and was installed complete with base, shaft, pillow blocks and bearings, as well as with flexible couplings for completing the connection to the Doble water wheel by which it is driven. With this generator the Stanley company also furnished a complete switchboard and exciter, together with three 600-kilowatt step-up transformers for raising the generator voltage to 42,000 volts, 52,500 volts or 63,000 volts, star connection, these various voltages being determined upon in order that the power house might be operated in parallel with the other power houses of the Bay Counties system. The transformers are of the Stanley standard "Type W" form, and are oil-insulated and water cooled.

The water wheel for driving the 900-kilowatt generator installed by the Valley Counties Power Company in the Butte Creek plant is of the Doble type, built by the Abner Doble Company, San Francisco, and the details of which are shown in the line engraving appearing on page 177.

The drawing given is sufficiently explicit as to require no detailed explanation beyond the fact that the nozzle used is of the Doble needle regulating type similar in construction and in principle of operation to that used in the Snoqualmie plant of the Snoqualmie Falls Power Company, and which has been described in these columns, January, 1900.

SAY "APERIODIC", NOT "DEAD-BEAT."

CARL HERING, in discussing an admirable paper recently read by Caryl D. Haskins before the Electrical Section of the Franklin Institute on "Electrical Measuring Instruments,"* suggested the substitution of the word "aperiodic," for the more or less objectionable term "dead-beat," as used in electrical instrument phraseology. The latter term is undoubtedly expressive, for it means that the beats of oscillations of the needle are deadened, but the not inelegant word "aperiodic" signifies precisely the same thing. It is derived from two words meaning that the needle has no period of oscillation; that is, that it does not oscillate like a pendulum.

*The Journal of the Franklin Institute, Volume CLV, page 82, February, 1903.

INDUSTRIAL.

DETERMINING THE PRICE FOR LIGHT AND POWER.

ON account of the inability to store large quantities of electrical energy for future delivery, the electric power station is forced to manufacture the greater portion of its output at the time of the customer's demand. The result of this condition is that the company operating the station has to carry a very large investment, which, for a considerable period of the day, must remain idle, this period depending absolutely on the amount of time which the customer makes use of his maximum demand. Now, as the interest charges of a station are a very large proportion of its cost of production, it is but natural that the company can furnish electrical energy cheapest to the customer who uses his maximum demand on the station for the greatest number of hours each day; therefore, it follows that the electrical energy should be sold on a sliding scale, depending on the maximum demand of the customer and the total amount of electrical energy supplied.

These data can be secured by the use of the Wright discount meter, which is connected in series with the recording wattmeter,

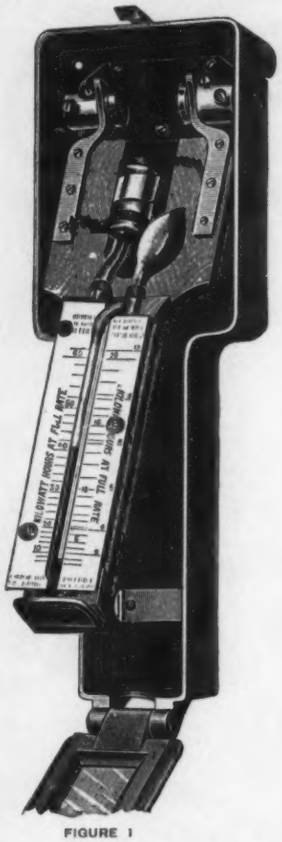


FIGURE 1

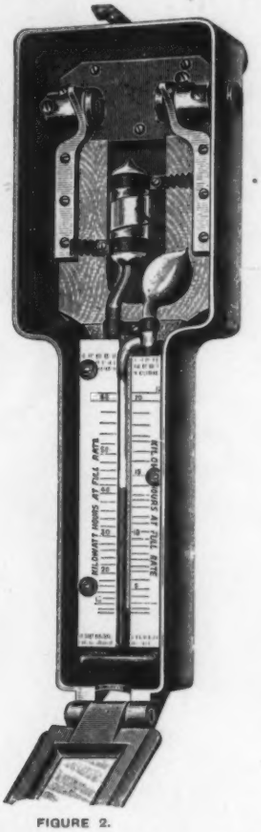


FIGURE 2.

and registers in amperes the maximum demand on the station at any one time. In order to be ready to supply this demand, the central station company has to reserve a certain proportion of its total investment, the interest on which the customer should certainly pay, besides the necessary cost of production and profit on the total amount of electrical energy used. To accomplish this the customer may be charged at one rate for the first hour's use of the maximum demand each day, and for all electrical energy used in excess of this at a much lower rate.

The use of storage batteries does not affect this principle. Storage batteries do not diminish the necessary investment in mains, feeders, transformers, etc., at all. Storage batteries do, it is true, diminish the necessary investment in dynamos and engines, but at present prices the cost of the batteries is practically as much as the cost of the dynamos and engines they displace. The advantages of batteries lies not in the saving of first cost or investment charges so much as in the incidental advantages. The great Edison companies that have the largest installations of storage batteries also find it necessary to use the Wright discount principle of charging to get the best results.

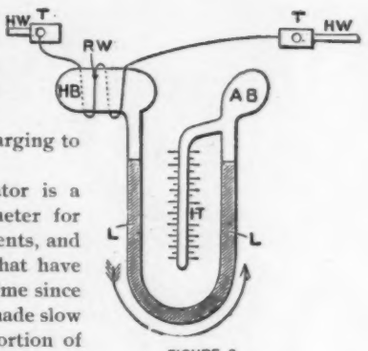


FIGURE 3

The Wright discount indicator is a maximum recording ampere meter for either direct or alternating currents, and records the maximum amperes that have passed through it at any one time since it was last set. It is purposely made slow acting for the reason that any portion of the plant of an electric company will stand a very large overload for a minute or two and a less overload for a longer time. The meter is therefore so designed that if the maximum load lasts only five minutes, the meter will register about 80 per cent.; if ten minutes, 95 per cent., and the full 100 per cent. when the load has continued about half an hour. Some indicators reach the maximum in twenty minutes, some in forty to fifty minutes.

Figure 3 shows the working parts in principle. A liquid is hermetically sealed in a glass tube fitted with a heating bulb, around which the wires or heating strip pass, as shown. The passage of the current heats the air in the left hand bulb and the expansion of the air forces the liquid into the right hand bulb and indicating tube. The liquid when once spilled over into the indicating tube cannot return until the meter is reset.

Figure 4 is an exterior view of the actual meter. The working parts are enclosed in an iron case (which can be securely sealed against tampering), fitted with a glass front so that the meter can be read without having to open the hinged door. The case is so constructed that the meter can be placed in any locality without the slightest danger of damage, and as the only moving part is the liquid, which is hermetically sealed in the tube, it is practically impossible for the meter to get out of order. Referring to Figures 1 and 2, it will be seen that the glass tube is carried on a substantial backing, which is so hinged that the meter can be reset by tipping up the tube (see Figure 2) and allowing the liquid to run back out of the indicating tube into the side tubes.

It is the difference of temperature between the two bulbs that work the meter. Any change, however, in the temperature of the external air affects both bulbs equally, and hence does not affect the reading of the meter.

In order to facilitate the reading of the meter and the determination of the customer's bill, the Wright discount meter scale may be so calibrated that on one side it will read in amperes and on the other indicate directly in watthours, without any calculation, the amount of electricity to be paid for monthly at the full rate.

To arrive at the amount of electricity to be paid for at the low rate, subtract the watthours as shown by the reading of the Wright discount meter from the watthours as shown by the recording wattmeter, and the difference between these two readings will represent the watthours to be charged for at the low rate. For example, assume the meters to be connected on a 110-volt circuit and that the Wright discount meter reads ten amperes on the ampere scale. On the watthour

FIGURE 4

scale the reading would be 33,000 watthours (10x110x30), on the basis of charging the full rate for the equivalent of one hour's use of the maximum demand per day, thirty days each month. If the recording wattmeter shows a total consumption of 50,000 watthours, then the customer will be charged at the full rate for 33,000 watthours and at the low rate for 17,000 watthours.

It is, of course, not absolutely essential that the system of charging above outlined be strictly adhered to, as it may be found in some cases advantageous to vary the details somewhat. One large company, instead of charging the full rate of the first hour's daily use of the maximum demand throughout the year, charges the full rate for the first half hour's daily use during the six summer months and during the six winter months charges the full rate for the first hour and a half daily use of the maximum demanded. In both summer and winter all of the excess consumption is charged for at a lower rate.

Another large company, which has installed a very large number of Wright discount meters, varies each month the number of hours for which the full rate is charged, making graduations from ten hours in midsummer months to fifty hours in midwinter months.

It should be noted that the Wright system enables the company to make a lower average price to its customers than is possible on any flat rate system. Supposing, for instance, that a company is charging 18 cents and 8 cents on the Wright system, and is getting an average price from all its customers of 13 cents. If the company should change back to a flat rate of 13 cents it would lose a number of its customers who had previously paid less than 13 cents and would gain a number of customers whose use of current is such as to make an 18 cent rate necessary for the company to show a profit on supplying them, but only pay 13 cents on the flat rate. The result will be that the company loses money on its new customers who pay 13 cents but should pay 18, and does not make any money on the customers who should pay only 8 or 10 cents, because these customers will not take current at 13 cents. The result is that in order to make the same net income as before the company must charge a higher rate than 13 cents. In other words, it takes a smaller average rate on the Wright system to give a certain income than it does on a flat rate system.

The Wright discount meters are now being used quite extensively by a number of companies, who find that this system of charging is conducive to a very large increase in business, especially among the most profitable customers to a central station, namely, the thousands of users of light whose demands on the station last for a considerable number of hours each day. For further information apply to the General Incandescent Arc Light Company, Pacific Coast office, Rialto Building, San Francisco.

THE WESTON ELECTRICAL INSTRUMENT COMPANY ESTABLISHES A NEW YORK OFFICE.

FOR the greater convenience of its numerous customers and to better care for the continued increase of business in New York and vicinity, the Weston Electrical Instrument Company, Waverly Park, Newark, N. J., has opened a New York office at 74 Cortlandt Street. This office will be under the management of Mr. Caxton Brown, who has a theoretical as well as a practical knowledge of the different instruments manufactured by the Weston company and their particular adaptabilities. This will enable any purchaser or any person visiting or doing business in New York, who may wish to make inquiries relative to electrical measuring instruments, to come in direct contact with a man who is properly qualified to answer such inquiries.

There will be a showroom in connection with the New York office, in which will be exhibited the different types of Weston instruments and their special advantages, also the individual parts which make up the instruments. Besides being a great convenience to customers, the New York office will eliminate much correspondence in the nature of inquiries, thus reducing time of delivery of orders.

A general impression has prevailed that the Weston Electrical Instrument Company make only voltmeters and ammeters, which is not the case. Having what are credited with being the largest and best equipped works in the world for the production of electrical measuring instruments of all kinds, the company is particularly fitted to turn out work of any special character, in which the highest excellence of mechanical and electrical work and design are the important features. They have, in fact, been turning out a large amount of special laboratory apparatus for several years past, and are now prepared to make standard cells, standard resistances, galvanometers, and the highest grade of special bridge work, speed indicators, etc.

The Weston Electrical Instrument Company extends a cordial invitation to all interested in the subject of electrical measurements to make use of its New York office either for the purpose of inquiry on the technical points involved or for the prospective purchasing of instruments.

CONCERNING THE WESTON-KEYSTONE LITIGATION.

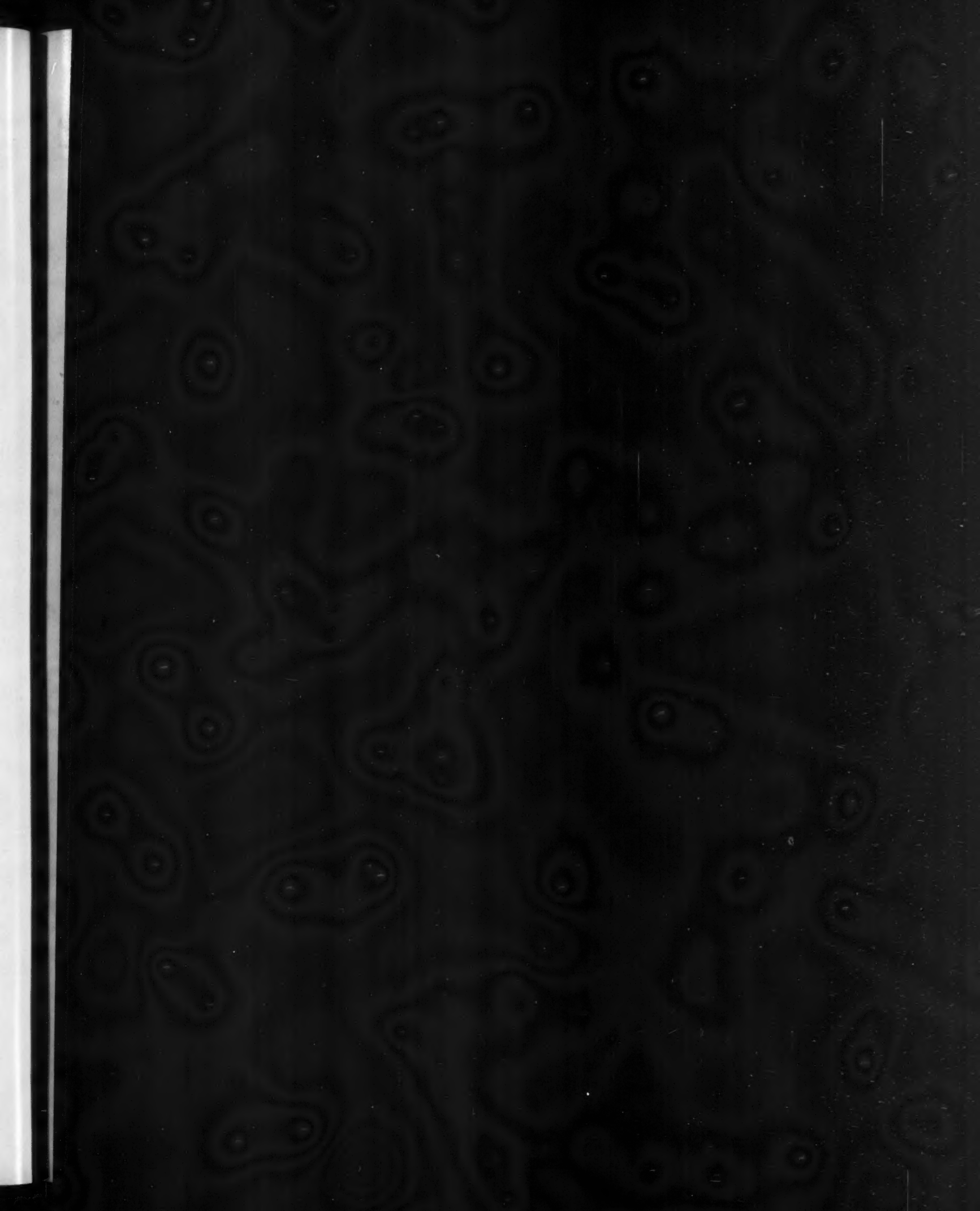
IN a letter to this publication dated February 17th, The Cutter Electrical and Manufacturing Company, sales agent for the Keystone Instrument Company, makes the following self-explanatory statements regarding the injunction recently handed down by Judge Coxe restraining the Keystone Instrument Company from the production of certain types of electrical measuring instruments:

The Keystone Instrument Company has been sued upon two patents covering the dynamometer type of alternating current portable instruments, and a preliminary injunction has been issued by Judge Coxe of the Circuit Court of New York. An appeal has been taken by the Keystone company from this decision and the matter will be carried to a higher court for final adjudication. It should be noted that the decision given is not final, as is stated by the Weston company in its advertisements, and that the patents referred to cover absolutely nothing except alternating current portable voltmeters, milli-voltmeters and wattmeters, leaving untouched the entire line of direct current instruments, whether of the switchboard or portable types, and that, also, it does not cover alternating current switchboard instruments.

Notices which have been published regarding this preliminary injunction have been so worded as to give the impression that the entire Keystone line is affected, and we will be very glad to have this erroneous impression corrected. The Keystone company is making a fight against monopoly in this case on principle and not because of the value of the instruments involved, for the business affected by the decision constitutes less than 1 per cent. of the output of the Keystone factory.

The preliminary decision procured will have less advertising value when its scope is explained, and we feel that the false impression which has sought to be spread broadcast in the electrical press of the country should be corrected as a matter of simple justice.

THE ST. JOSEPH-SOUTH BEND TRANSMISSION.

THE St. Joseph and Elkhart Power Company of Mishawaka, Ind., is installing a large hydraulic plant on the St. Joseph River, near Mishawka, including power house, dam and hydraulic and electrical equipment for the generation and transmission of electrical power to the cities of South Bend, Mishawaka and Elkhart, Ind., and adjacent territory. The energy will be used for general lighting and power purposes. The plant will contain four Westinghouse, 1000-kilowatt, 13,200-volt, revolving-field alternators, and two 125-kilowatt exciters, all to be direct-coupled to horizontal shaft water wheels. The company has also ordered a complete high-tension, low-capacity switchboard, including a complete equipment of the latest type of electrically operated Westinghouse oil-break switches for operation at 13,200 volts.

A decision has just been handed down by Judge Ray in the suit brought by the General Electric Company against J. B. Wise, of Watertown, N. Y., on the J. C. Tournier patent, No. 559,232, April 28, 1896, incandescent lamp socket, declaring that the patent is valid and infringed by the defendant's device, which is an Edison type lamp socket, and an order for an injunction has been issued restraining the defendant from manufacturing any more such sockets.